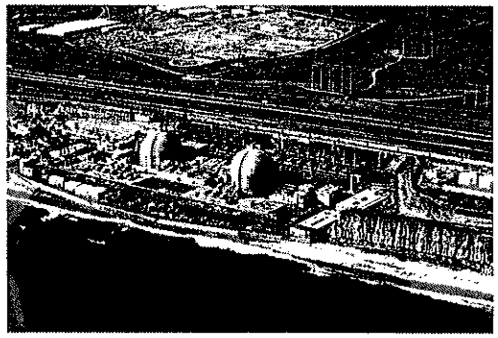

Seismic Reliability Study of San Onofre Nuclear Generating Station Non-Safety Related Structures, Systems, and Components

San Onofre Nuclear
Generating Station
San Onofre, California
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SGH Project 108036

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APPENDICES

1. OBJECTIVE

The objective of this study is to identify important-to-reliability, non-safety-related (NSR) structures, systems, and components (SSCs) at the San Onofre Nuclear Generating Station (SONGS) that could be the cause of a prolonged outage due to a major seismic event. Specifically, the study evaluates NSR SSCs that are required for power generation, including the switchyard, which are, for the purposes of this study, identified as important-to-reliability.

2. PLANT INFORMATION

2.1 Plant Location and Configuration

SONGS consists of two nuclear reactor units, San Onofre Unit 2 and San Onofre Unit 3, which are each capable of generating approximately 1,100 megawatts (MW) of electrical power. Each unit is a separate and independent power plant with no common support equipment required for power generation, with the exception of the site fire protection, carbon dioxide (CO_2) and nitrogen (N_2) supply, and instrument air. The power generation portions of each plant are virtually identical.

SONGS is located along the Pacific coastline south of San Clemente and west of Interstate Highway 5. The plant is located entirely within the boundaries of the U.S. Marine Corps Camp Pendleton Base in northern San Diego County. An aerial view of the site is shown on Figure 2-1. The site was created by excavating the original bluff to remove the terrace deposits and create a level area for the plant on what is known as the San Mateo Sandstone Formation, which consists of very dense sand approximately 900 feet (ft) deep with an average shear wave velocity of approximately 1,900 feet per second (ft/sec) in the top 100 to 150 ft depth. The site soils directly supporting the plant structures were extensively investigated during plant construction and found not to be susceptible to liquefaction. The switchyard is located on a slope that rises to the original bluff level. There are two benches cut into the slope that provide the access roads for the two bus lines that comprise the switchyard. There are offices and shop / storage buildings adjacent to the plant's operational structures. The buildings shown on Figure 2-1, which are east of Interstate 5, are additional offices and warehouse facilities that support the plant's operations.

The SONGS units use ocean water to condense the pressurized steam that has expanded through the turbines and to provide cooling of other plant water systems through heat exchangers. The ocean water for each unit is channeled from offshore intake structures through buried conduit systems to the on-shore intake structure where it is channeled to the circulating water pumps of each unit. The water from each unit is then discharged back to the ocean through separately buried offshore discharge conduits.

SONGS is licensed by the U.S. Nuclear Regulatory Commission (NRC), which issues policies and regulations governing the initial construction, modifications, and operations of nuclear power reactors.

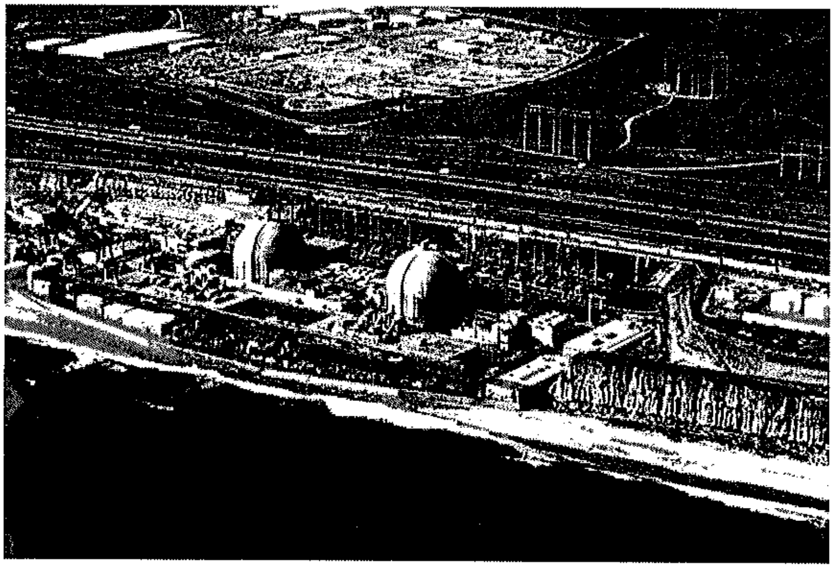

Figure 2-1 Aerial Site View of Both Units

2.2 SONGS Seismic Design Basis

Each of the two units contains safety-related (SR) SSCs and NSR SSCs. The plant's SR SSCs include, but are not limited to, the reactor, nuclear steam supply system (NSSS), containment, and associated emergency equipment. The NRC regulates the design parameters and operation of SR SSCs, which have been designed to allow for the safe-shutdown of a nuclear power plant in the event of a large seismic event, specifically the design-basis earthquake (DBE). The DBE, also known as the safe-shutdown earthquake by the NRC, is associated with an extremely low probability of occurrence.

The SONGS Updated Final Safety Analysis Report (UFSAR), (UFSAR, Current) identifies three categories of SSCs that have specific seismic design criteria.

- **Seismic Category I (SC I).** All SC I SSCs are SR and are, therefore, not evaluated as party of this study[1]. SC I SSCs are designed to remain functional and / or retain structural integrity if a DBE occurs. SC I SSCs must meet the DBE design conditions, as mandated by the NRC and specified in the Code of Federal Regulations (CFR) (10CFR100AppA, Current). The design requirements for SC I SSCs are determined by using a design spectrum shape that has a peak ground acceleration (PGA) value of 0.67g.

[1] SC I SSCs are not evaluated as part of this study (CEC, 2008) because they are designed to withstand a safe-shutdown earthquake without damage.

- **Seismic Category II (SC II).** All SC II SSCs are NSR and were evaluated as part of this study. SONGS SC II SSCs include equipment whose limited damage could interrupt power generation. SC II SSCs, with the exception of the switchyard, were designed to meet an effective static seismic design loading of 0.20g horizontal and 0.13g vertical with no increase factor on allowable stress values. In addition, the design involved verifying that the effective static seismic design loading was not lower than the building code requirements at the time of the design. This was the general seismic design criteria for all Southern California Edison (SCE) power plant structures and equipment anchorage which were in use at the time of plant design.

  The 230 kilovolt (kV) switchyard SSCs were designed to meet the SCE transmission facility effective static seismic design loading of 0.50g horizontal, which was the SCE transmission facility design criterion in use at the time of plant design. This SCE substation design criterion was adopted following the 1971 San Fernando earthquake.

- **Seismic Category III (SC III).** SC III SSCs are NSR SSCs that are not SC I or SC II SSCs but whose failure could inconvenience normal plant operations. Only a few of these SC III SSCs were considered within the scope and evaluated as part of this study. These SSCs were designed to meet the building code requirements at the time of design.

In addition to the three SC categories, there is an additional classification for those SC II SSCs that are located in close proximity to SC I SSCs. These SSCs are required to maintain their structural integrity, including the anchorage at a DBE loading level. This special case of SC II SSCs is denoted as seismic interaction (SI) II/I and is defined as equipment that is not SC I but whose collapse or failure could result in the loss of the safety functions of SC I SSCs.

The design criteria for the plant are viewed as minimum allowable values per the applicable codes and standards that are associated with the SSCs. These standard allowable values have a built-in seismic margin, although there is often a significant seismic margin beyond the built-in margin due to conservatisms that are integrated in the design process.

3. STUDY METHODOLOGY

The following five-phase approach was developed to address the important-to-reliability NSR SSCs.

1) Phase I – Identify important-to-reliability NSR SSCs
2) Phase II – Identify seismic capacity screening criteria
3) Phase III – Determine SONGS review level earthquake
4) Phase IV – Evaluate seismic capacity of important-to-reliability NSR SSCs
5) Phase V – Develop repair / replacement duration estimates and mitigation plans

Figure 3-1 provides an overview of these sequential phases. A similar phased approach is used for NSR buildings that house important-to-reliability SSCs. A different methodology is used for Phase IV to evaluate the capacity of NSR buildings that house important-to-reliability SSCs. This methodology is summarized separately in Section 3.6.

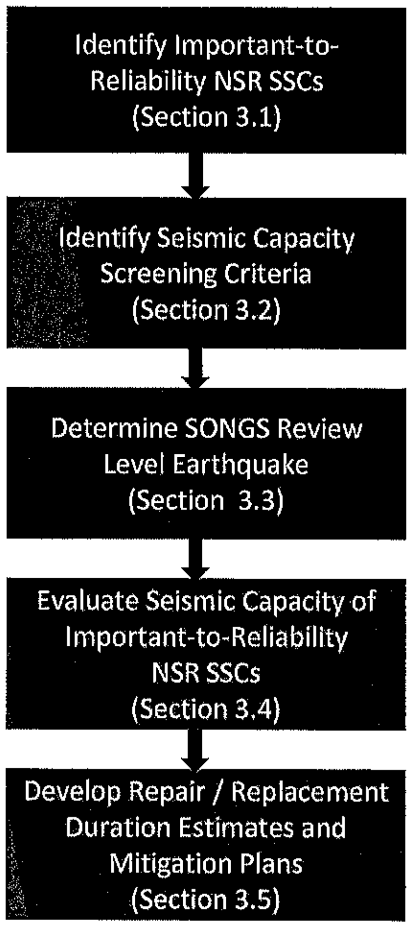

Figure 3-1 Methodology Overview

3.1 Phase I – Identify Important-to-Reliability NSR SSCs

The first phase of this process involves identifying the important-to-reliability NSR SSCs. Figure 3-2 shows the general logic flow that is used to identify the important-to-reliability NSR SSCs. Only NSR SSCs that are required for power generation are included in the final list. The first step involves reviewing the SCE Quality and Classification List (SCE Document No. 90034), which is a list that contains the SSCs at SONGS and their seismic category (SCE, 2009). The next step consists of removing the SSCs in the SCE Quality and Classification List that are outside the scope of this study. First, the SC I SSCs are identified and removed from consideration given that they are outside of the scope. Then, the SSCs not required for power generation are identified and removed from consideration because these SSCs do not impact the power generation reliability. The SSCs remaining on the list constitute the important-to-reliability NSR SSCs (see Appendix B).

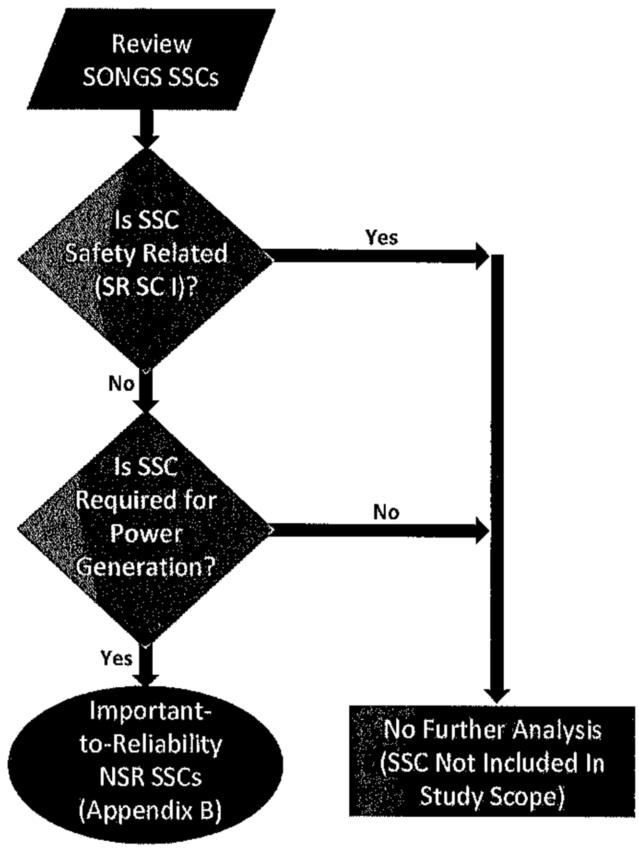

Figure 3-2 Important-to-Reliability NSR SSCs Identification Process

3.2 Phase II – Identify Seismic Capacity Screening Criteria

The next phase involves identifying the seismic capacity screening criteria. NSR SSCs are, at a minimum, designed to meet the building code seismic requirements at the time that they were designed. However, historical earthquake performance has shown that such equipment typically has inherent seismic capacity much greater than the minimum building code seismic requirements. Over the past 20 years, a group known as the Seismic Qualification Utility Group (SQUG)[2] has collected data and documented the results about the performance of various SSCs at large power / industrial plants during and following an earthquake (referred to as earthquake experience data) (SQUG, 1991). SQUG averaged the earthquake response spectra[3] of sites having facilities with representative SSCs that experienced strong ground motion seismic events to determine a ground motion level for which power plant SSCs have survived without damage. This ground motion level is described by a seismic capacity spectrum (referred to as the "reference spectrum" by SQUG). The 5% damping seismic capacity spectrum is characterized by a spectral acceleration level of 1.2g over a frequency range of 2.5 to 7.5 hertz (Hz) and a PGA of 0.5g, which is depicted on Figure 3-3 as the bold line.

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[2] SQUG was formed in the early 1980s to develop a generic methodology to resolve Unresolved Safety Issue (USI) A-46, which was concerned with verifying the seismic adequacy of equipment that was already installed in operating nuclear power plants. Working in conjunction with the regulatory authorities and industry, SQUG developed a methodology and procedure to apply earthquake experience data to demonstrate the seismic capacity of electrical and mechanical equipment for resolution of USI A-46. SQUG developed the "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment" which provided a generic means of applying this experience data to evaluate the seismic adequacy of mechanical equipment, electrical equipment, distributive systems (i.e., ducting, cable trays, conduit, etc.) and passive items (i.e., tanks, heat exchangers, etc.) that are typically part of the balance of plant at a nuclear power plant (SQUG, 1991). The GIP implements this SQUG approach and includes the technical approach, generic procedures, and engineering guidance. The NRC embraced the use of experience-based methods for resolution of USI A-46 in Generic Letter (GL) 87-02, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46" (NRC, 1987).

[3] A response spectrum is defined as a plot of the maximum response of an array of single-degree-of-freedom systems of different natural frequencies, each having a damping value expressed as a percentage of critical damping.

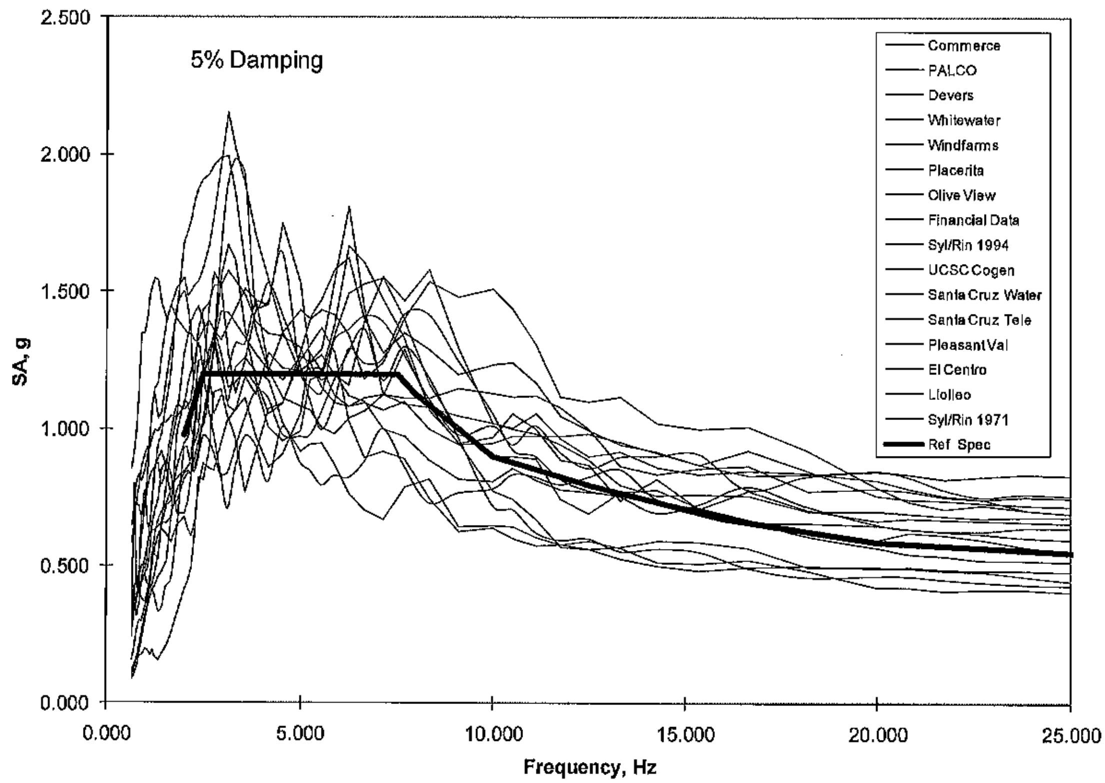

Figure 3-3 Average Horizontal Response Spectra for SQUG Database Sites Compared to the Seismic Capacity Spectrum (also known as the Reference Spectrum)

Based on the number and diversity of SSCs that have survived the motion level represented by the seismic capacity spectrum, this motion level was established as a high confidence of a low probability of failure (HCLPF) (EPRI, 1994, 2002 and 2009). As such, the seismic capacity spectrum does not represent a failure level but rather a level for which there is a high confidence that failure of the SSCs will not occur. The data contained in the SQUG database demonstrate that the actual mean failure level, otherwise known as fragility, is typically at least 2 to 3 times the seismic capacity spectrum (EPRI, 2002 and 2009). This failure margin allows the seismic capacity spectrum to be used as a conservative measure of seismic capacity to screen the important-to-reliability NSR SSCs for the site-specific seismic demand conditions.

3.3 Phase III – Determine SONGS Review Level Earthquake

The seismic capacity spectrum was derived using actual earthquake experience data and represents a conservative measure of seismic capacity for the important-to-reliability NSR SSCs. To understand if this capacity is sufficient to demonstrate adequate reliability for power generation, the seismic demand that is bound by the seismic capacity needs to be determined considering the location and the site-specific conditions at SONGS. Site-specific earthquake ground motion conditions are described by the SONGS probabilistic seismic hazard analysis (PSHA) that was recently updated in 2010 (SCE, 2010).

The SONGS 2010 PSHA determined each spectral acceleration value associated with a given oscillator frequency as a function of annual return period. The annual return period is the number of years it may take for the spectral acceleration value to occur (i.e., a 1,000-year return signifies that the value may occur once in 1,000 years). These sets of functions are denoted as hazard curves. For a given annual return period, a uniform hazard spectrum (UHS) can be plotted to provide the expected spectral content of the motion associated with that annual return period.

The seismic motion that is used for assessing the seismic capacity of the important-to-reliability NSR SSCs is referred as the SONGS review level earthquake. A UHS with a 1,000-year period was chosen for the SONGS review level earthquake. This is a highly unlikely event having an annual probability of exceedance of 0.1%. If SONGS operates through 2042 (assuming that its current license, which expires in 2022, is renewed for an additional 20 years), this motion level corresponds to about a 3.1% probability of occurring over the plant's remaining 31 years of operation.

The SONGS review level earthquake is shown on Figure 3-4. This motion is characterized by a maximum spectral acceleration level of 0.75g at a frequency of 5 Hz and a PGA of 0.32g at 5% damping.

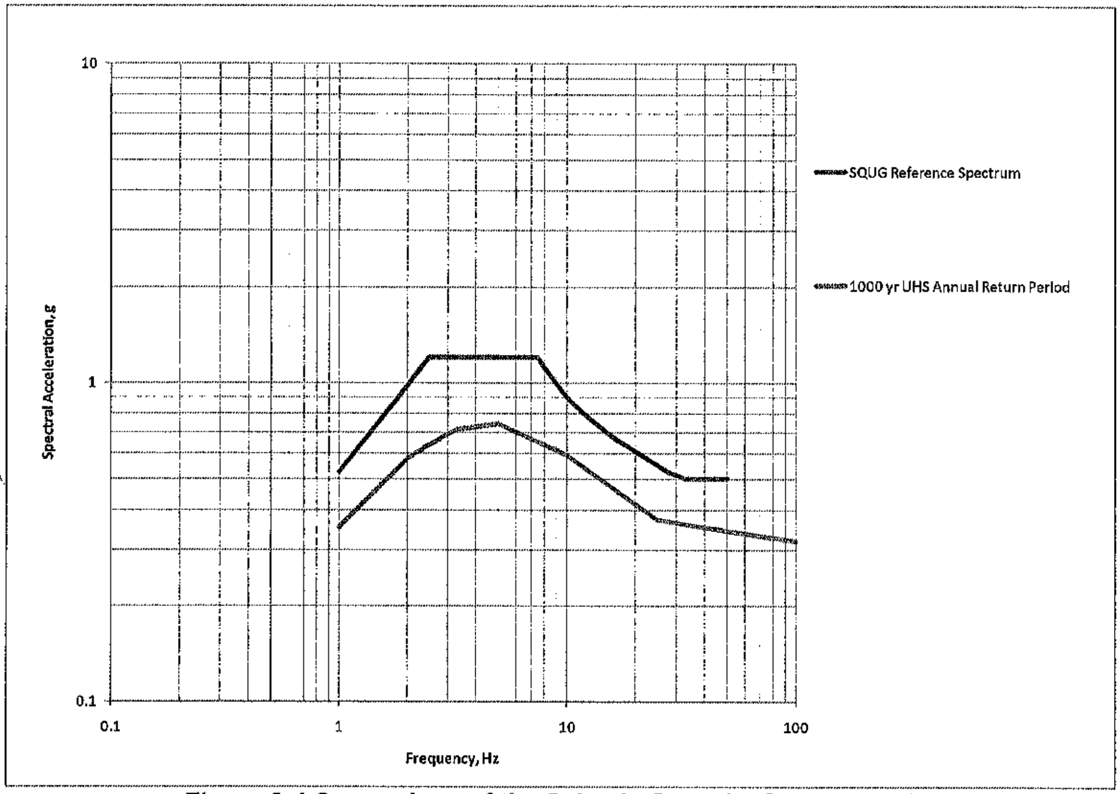

Figure 3-4 Comparison of the Seismic Capacity Spectrum with SONGS Review Level Earthquake (Using a 1,000-Year UHS Annual Return Period)

3.4 Phase IV – Evaluate Seismic Capacity of Important-to-Reliability NSR SSCs

Using the important-to-reliability NSR SSCs list that was generated during Phase I and included in Appendix B, the next phase involves the screening of these SSCs to determine the important-to-reliability NSR SSCs that have a seismic capacity greater than the SONGS review level earthquake.

The seismic capacity screening is accomplished by reviewing plant design documents, conducting walkdowns, and using the SQUG database. Three specific criteria are used in the seismic capacity screening:

- Anchorage
- Spatial Interaction
- Functionality

SI II/I SSCs are screened only for the spatial interaction and functionality criteria given that their anchorages were already designed to the DBE loading. Figure 3-5 shows the general logic flow used to accomplish the screening.

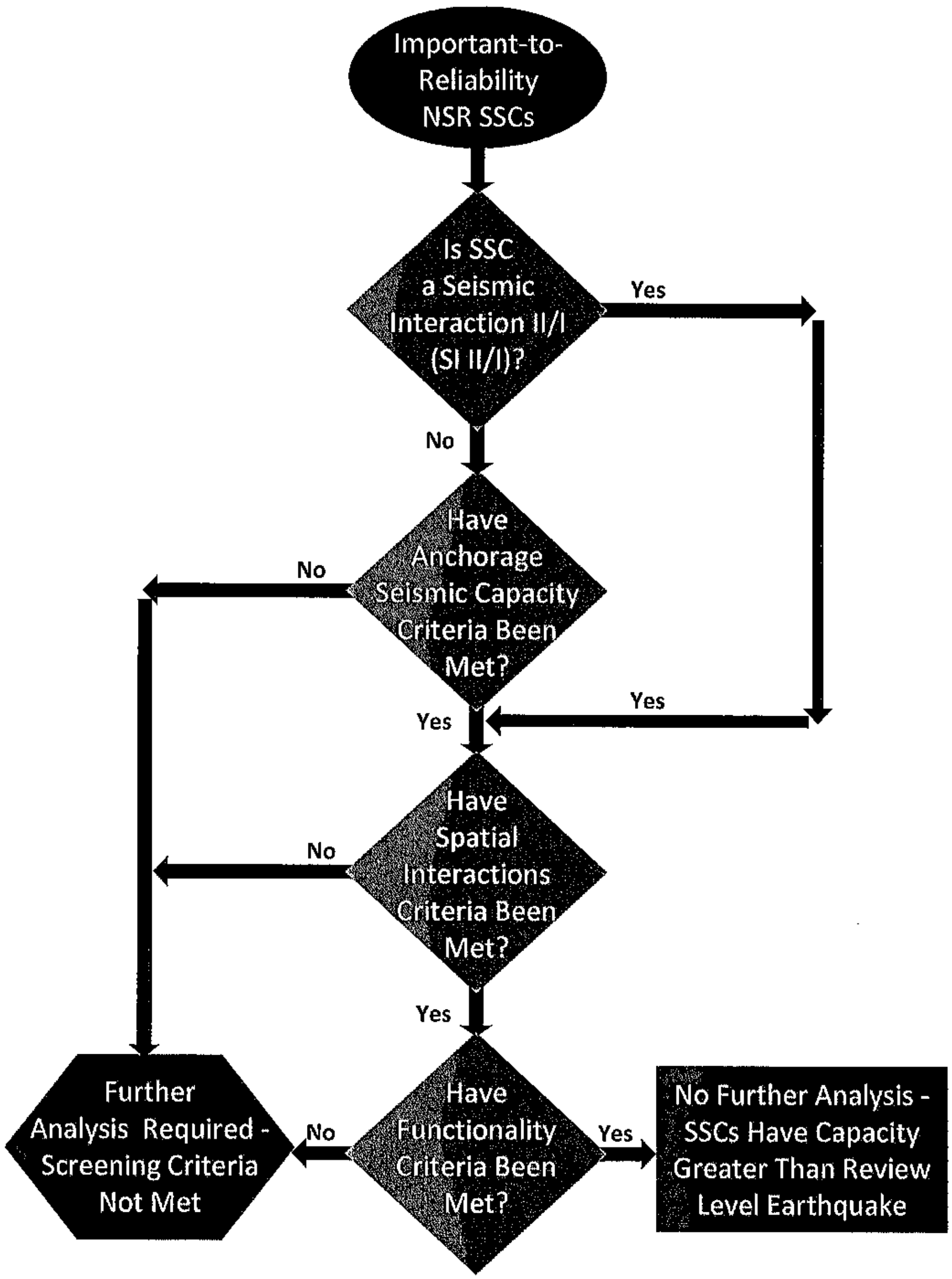

Figure 3-5 Seismic Capacity Screening Process

The anchorage seismic capacity screening involves verifying that the anchorage can withstand a SONGS review level earthquake. In performing the anchorage evaluation, the plant's existing documentation, including drawings, specifications, calculations, and typical details are reviewed. In addition, the anchorage is visually inspected during a walkdown to check for adequate installation and to determine if the anchorage load path is sufficient. Specifically, the strength of the equipment is assessed to verify that it is able to effectively transfer the loads to the anchorage. Base isolation systems for equipment must also be evaluated for seismic adequacy.

The spatial interactions screening involves performing the following interaction evaluations:

- Proximity – Determine the impact from adjacent equipment due to relative motion.
- Structural failure and falling – Determine the impact from the failure of overhead and adjacent equipment, structures, or architectural features.
- Flexibility – Determine the impact of attached lines due to relative displacements.

The functionality screening involves determining if the candidate SSC is similar to SSCs in the existing seismic experience database. This screening consists of examining the design documentation (e.g., specifications and drawings) to determine similarity to the actual SSCs contained in the seismic experience SQUG database. If the SQUG seismic experience database does not include similar SSCs, a specific evaluation is performed.

SSCs whose seismic capacity is greater than the SONGS review level earthquake (i.e., SSCs that demonstrate no seismic vulnerabilities at the SONGS review level earthquake level) are screened out, and no further analysis is required. For those SSCs that are not screened out, a more rigorous evaluation of seismic capacity is necessary. A fragility evaluation is conducted to determine the probable failure modes of the SSC. If the SSC seismic capacity is shown to be higher than the SONGS review level earthquake, then no further evaluation is needed. If the SSC seismic capacity is shown to be lower than the SONGS review level earthquake, then this SSC is added to the subset of SSCs that require repair / duration estimates. Figure 3-6 shows the general logic flow used for this further seismic evaluation.

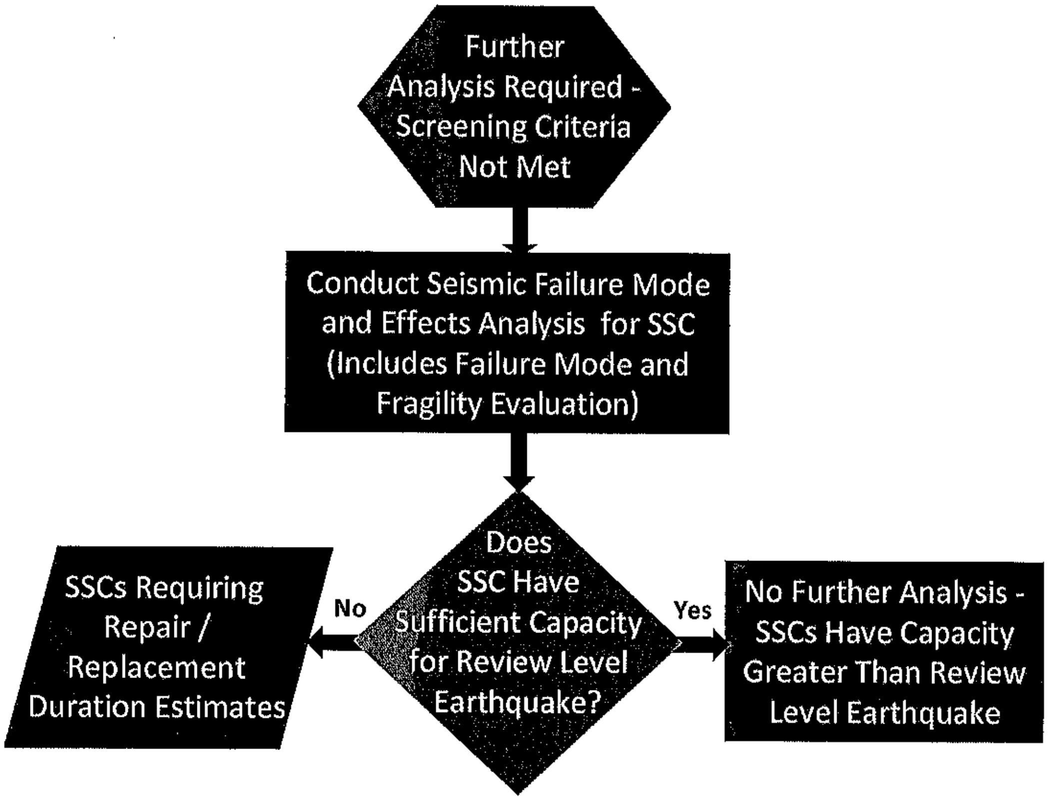

Figure 3-6 Further Seismic Evaluation Process

3.5 Phase V – Develop Repair / Replacement Duration Estimates and Mitigation Plans

Having established the probable failure modes and likely extent of damage to those SSCs that do not have seismic capacity equivalent to the SONGS review level earthquake, the next phase is to determine the conceptual level repair / replacement time duration estimates for those SSCs. The repair / replacement time duration estimates are evaluated to determine whether they represent the possibility of a prolonged outage following a major seismic event. For any SSCs identified as requiring a prolonged outage under those circumstances, mitigation plans are developed by SCE. The general logic flow used for this final phase is shown on Figure 3-7.

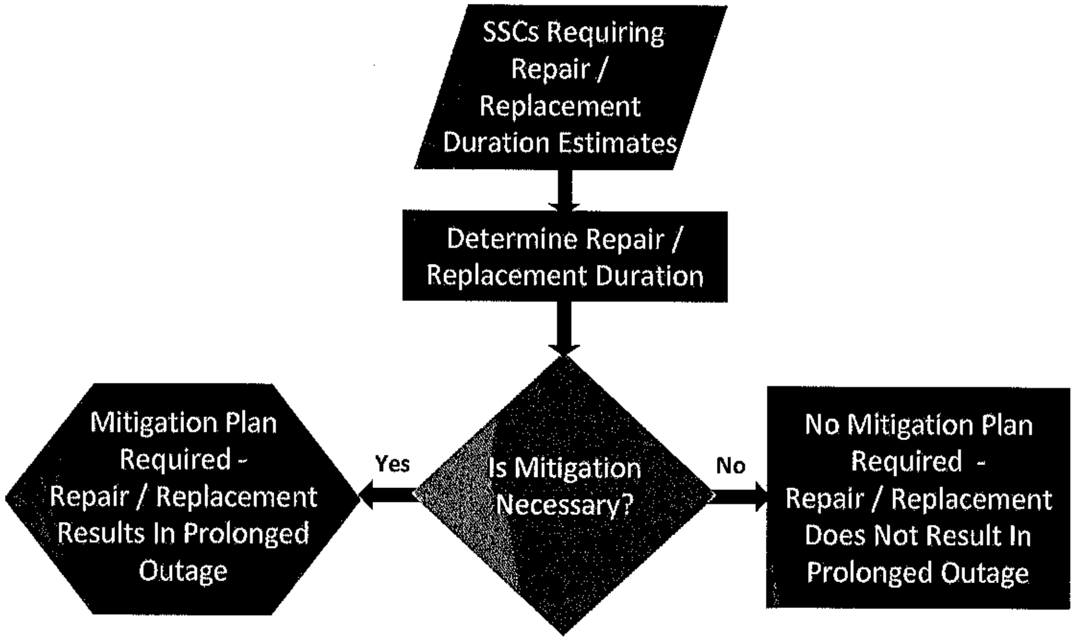

Figure 3-7 Repair / Replacement Duration Estimate and Mitigation Plan Development Process

3.6 Screening Process for NSR Buildings that House Important-to-Reliability SSCs

This seismic capacity screening process described in Section 3.4 is not applicable for NSR buildings that house important-to-reliability NSR SSCs. Instead, a commonly accepted methodology developed by the Federal Emergency Management Agency (FEMA) (FEMA, 2000, 2006) is used. This methodology is used by design professionals to assess building safety following earthquakes and is contained in national consensus software designated as HAZards United States (HAZUS). Within the HAZUS methodology are seismic capacity functions for different model building types that can be used to assess the risk of earthquake damage to these traditional commercial structures. Using the HAZUS methodology, the capacity can be estimated for the selected NSR buildings that house important-to-reliability NSR SSCs, considering the acceptable damage state and type of construction. These procedures are discussed in detail in Appendix E.

4. RELIABILITY STUDY RESULTS

4.1 SONGS Important-to-Reliability NSR SSCs

Using the five-phase methodology described in Section 3.0, important-to-reliability NSR SSCs were identified. An initial list, provided in Appendix B, of important-to-reliability NSR SSCs was generated following a review of SCE's Quality and Classification List. However, this equipment classification list could not be used to complete seismic capacity evaluation because it only considered general component types within a system and did not specify the individual component identification and location. Separate lists were prepared for the electrical equipment (see Appendix C) and the mechanical equipment (See Appendix D). These lists provide the identification and location of each specific important-to-reliability NSR SSC. In addition, Table 4-1 lists the plant's systems associated with power generation that were identified during this process. In order to prepare these lists, plant system documentation and the process and instrumentation diagrams (P&ID) or one-line electrical drawings were reviewed to identify specific components.

The primary SSCs associated with power generation are housed in the turbine building, the main steam isolation valve (MSIV) area, the control area of the auxiliary building, the tank building, and the intake structure. Additional SSCs used for the distribution of the generated power are located in the plant yard. While the turbine buildings were classified as SC II, the turbine buildings are designed for SI II/I to resist the DBE loading. Additionally, while the mechanical, electrical, and distribution system components housed within the turbine buildings were classified as SC II, their anchorages would be able to resist DBE loading. This was confirmed by a walkdown and review of plant design documentation.

Table 4-1 Plant Systems Associated with Power Generation

Steam and Power Conversion Systems • Steam System • Feedwater and Condensate Systems • Turbine Lube System • Condenser Air Removal System • Main Condenser System • Generator Seal Oil System • Electro Hydraulic Oil System
Balance-of-Plant Water Systems • Circulating Water System • Turbine Plant Cooling Water System • Main Generator Cooling System • Demineralized Water Systems
HVAC Systems • Control Area-Auxiliary Building • Turbine Building
Electrical Systems • 22,000 V AC System • 6,900 V AC System • 4,160 V AC System • 480 V System • DC System • AC Control Power System • Lighting System • Excitation System • 230 kV Switchyard
Fire Protection System
Auxiliary Systems • Instrument Air System • N_2 Gas Supply System • H_2 Gas Supply System

Explanation:
1. V = volts
2. AC = alternating current
3. DC = direct current
4. N_2 = nitrogen
5. H_2 = hydrogen

There are only two non-power block NSR buildings – the SCE switchyard relay building and the San Diego Gas & Electric (SDG&E) switchyard relay building – that house operational important-to-reliability NSR SSCs. Both are separate single-story buildings that house relay racks. In addition, the Mesa warehouse is a NSR building that houses spare parts that can be used for repairing important-to-reliability NSR SSCs. These spare parts may be needed to repair the NSR SSCs that may sustain damage during a major seismic event.

The list of NSR buildings selected for evaluation is shown in Table 4-2.

Table 4-2 SONGS NSR Buildings Selected for Evaluation

Mesa Warehouse - Pre-engineered Steel Structure
Switchyard Relay Houses - Reinforced Masonry
• SCE – Single-Story Separate Building • SDG&E – Single-Story Separate Building

4.2 Capacity Evaluation Results

The equipment lists provided in Appendices C and D were used to perform the walkdown of the SONGS important-to-reliability NSR SSCs required for power generation as part of the seismic capacity evaluation. The walkdown was conducted by qualified seismic capability engineers who were certified as having successfully completed the SQUG training course[4] on seismic evaluation methods and who met the requisite education and engineering experience requirements. Since Units 2 and 3 are virtually identical in layout and components, Unit 2 was selected for the walkdown.

Within the SONGS plant's systems, some SSCs were identified as requiring a more rigorous analysis. The more rigorous analysis involved conducting a detailed seismic capacity evaluation that identified failure modes and fragilities. The NSR building structures identified as important-to-reliability were also evaluated using the HAZUS procedures and screened against the SONGS review level earthquake.

The SSCs were categorized as 1) having seismic capacity greater than the SONGS review level earthquake, 2) having seismic capacity less than the SONGS review level earthquake, or 3) requiring further review. A discussion of each of these categories is provided in the following sections.

[4] SQUG offers training courses to help users properly apply the various guidelines and tools developed by SQUG. This training is needed since the criteria and guidelines in the GIP included new methods and approaches as compared to the traditional methods for seismic qualification of equipment.

4.2.1 SSCs with Seismic Capacity Greater Than the SONGS Review Level Earthquake

The majority of the important-to-reliability NSR SSCs were determined to have a seismic capacity greater than the SONGS review level earthquake. A discussion is provided below for select power generation components.

4.2.1.1 Turbine / Generator Support Systems

The turbine / generator are the primary components for power generation. The primary mechanical support systems necessary to ensure turbine function are the steam / reheat system, the feedwater / condensate system including the condensate and feedwater pumps, the circulating water system, the condenser, the turbine plant cooling system, the lube oil system, the seal oil system, the stator cooling water system, and the hydrogen cooling system. These systems comprise pumps, valves, and the associated piping distribution systems. The primary electrical power support systems necessary to ensure turbine function are the medium voltage AC power system, the low voltage AC power systems, the DC power systems, and the associated cable tray and conduit distribution systems. The mechanical and electrical systems are controlled by various control interfaces and instrumentation systems, and associated wiring and cable distribution systems. The bulk of these components are housed within the turbine building of each unit and the auxiliary building with other components housed within the respective MSIV areas and tank buildings of each unit. The turbine building is mainly an open structure that has only local fans to promote air movement. The auxiliary building and portions of the turbine buildings have heating, ventilation, and air conditioning (HVAC) systems and the associated distribution ducts for air movement and heat removal. The important-to-reliability NSR SSCs of these mechanical, electrical, control / instrumentation, and HVAC support systems are of a similar type and configuration as non-nuclear power plant SSCs and are therefore similar to those found in SQUG's seismic experience database. The important-to-reliability NSR SSCs within these buildings were found to have anchorages able to withstand the DBE. Additionally, they were determined to be similar to the SSCs that performed well during and after an earthquake, based on earthquake experience. Thus, these SSCs were found to have a capacity greater than the SONGS review level earthquake.

4.2.1.2 Turbine / Generator

The rotating turbine shaft is supported and rides on 11 journal bearings, and longitudinal movements of the shaft are prevented using a single Kingsbury-type thrust bearing. These bearings use high oil pressure maintained by the lube oil system to prevent excessive movement of the shaft and metal-to-metal contact at the bearings. The Kingsbury-type of thrust bearing is designed to sustain very high thrust loads and remain functional.

The turbine / generator were considered to be special components requiring a more in-depth review. In general, turbo-machinery has high seismic capacity, and the earthquake experience with turbine generators is good. For an operating turbine, the most common issue has been associated with the loss of lube oil pressure during turbine coast-down caused by the loss of offsite power following an earthquake. The SSCs that comprise the turbine / generator coast-down lube oil system must maintain the necessary oil pressure required for the journal and thrust bearing to function during turbine / generator coast-down following the trip of a unit. If any disruption of the oil supply and pressure occurs during the coast-down period, then the journal and / or thrust bearings could be damaged. This type of failure mode, however, is associated with the design of the lube oil system and not the turbine / generator itself. The SONGS lube oil and seal oil systems were recently upgraded with redundant pumps and battery-backed power sources to prevent this failure mode from occurring. These components are anchored for the DBE loading, and their functionality will not be impacted after a SONGS review level earthquake event.

Except for a few isolated cases, earthquake damage to turbine components has otherwise not occurred. In one case, turbine / generator alignment was disturbed by the shifting of alignment shims during an aftershock. The SONGS turbine generator is not aligned in this manner.

It is important to note that a nuclear plant turbine is larger and operates at lower temperatures and pressures than a fossil-fired plant turbine. Until recently, the earthquake experience with larger nuclear plant turbines was limited. However, the turbine generators for the nuclear units at the Kashiwazaki-Kariwa Nuclear Power Plant were disassembled and inspected following the offshore magnitude 6.8 Niigataken-Chuetsu-Oki (NCO) earthquake that occurred near the plant in 2007. Four of the turbine generators were in operation at the time the earthquake occurred. While contact marks were found on the bearing surfaces, no issues that would have prevented turbine operation following the earthquake were discovered. The thrust bearings for the turbines were not the Kingsbury-type like those found at SONGS, but rather simple parallel plane-type bearings, which are not as rugged. Minor contact marks were found on the turbine bearing surface of all of the units, even those that had not been in operation during the earthquake. This suggests that the contact marks on the bearing surfaces were not earthquake-caused, but rather occurred during normal operation and start-up procedures. Some partially fractured turbine blades were also found in two of the units. However, these fractures were concluded to not be earthquake-related, but rather due to the over-speed test of the turbines during the initial unit start-up period. The plant's units had been operating with the partially fractured blades prior to the earthquake. This experience suggests that nuclear turbines have substantial seismic capacity and that functional performance following an earthquake is limited by the support system components and not the turbine generator itself. Consequently, the seismic capacity of the turbine generator exceeds the SONGS review level earthquake.

4.2.1.3 Offshore Intake Conduit and Main Intake Structure

The buried offshore intake conduit is SC I, with the exception of the segment from the auxiliary intake structure to the main offshore intake structure, which is SC II. However, the SC II segment of the offshore intake conduit has the same design as the SC I segment. In addition, controlled gravel that is not susceptible to liquefaction was used as backfill material for the entire length of the conduit. As a result, offshore intake conduits were determined as having a seismic capacity greater than SONGS review level earthquake.

The offshore intake structure, although SC II, was designed to withstand DBE loading and therefore has a seismic capacity greater than the SONGS review level earthquake.

4.2.1.4 Switchyard Relay Houses

There are two one-story relay houses located in the SONGS switchyard that contain relay racks. The relay racks were determined as having a capacity greater than the SONGS review level earthquake. These two buildings were evaluated with the HAZUS procedure, and the results indicated that they were likely to sustain moderate damage following a SONGS review level earthquake. This would result in the building being green tagged, which would allow continued unrestricted entry and access to the structure.

4.2.1.5 Spare Parts for Important-to-Reliability SSCs Stored in the Mesa Warehouse Building

The 100,000 square foot (sq. ft) warehouse is located in the Mesa area east of Interstate 5. The warehouse stores spare parts that may be required for repairing the transformer and switchyard important-to-reliability NSR SSCs. These spare parts are generally packed in crates and are stored either on the ground or on the lower shelves of the storage racks. The racks in the Mesa warehouse building are anchored to the concrete slab and are braced. Additionally, the racks have adequate moment connections between the horizontal members of the shelves and the rack legs. Although the racks may sustain moderate deformations and distortions during a SONGS review level earthquake, the access to and retrieval of the items stored on the shelves will not be difficult. However, some of the items, mainly those located on the top shelves, may slide or fall off the shelves during an earthquake. These would likely fall into the aisles between the racks, but would not impact the items that are stored on the lower shelves in the racks. Thus the damage to the stored spare parts required for repairing important-to-reliability NSR SSCs would be limited following a SONGS review level earthquake. The building was evaluated using the HAZUS methodology, and the results indicated that it would sustain extensive damage following a SONGS review level earthquake yet allow for access to the building contents. However, any debris that results from the extensive damage would come from the light roof elements. This debris would not affect the spare parts since they are crated and stored within the racks at ground level or on lower shelves.

4.2.2 SSCs with Seismic Capacity Less Than the SONGS Review Level Earthquake

The walkdown and the subsequent detailed analyses identified the following SSCs as having capacities below the SONGS review level earthquake:

- Main, Auxiliary, and Reserve Auxiliary Transformers
- Line Dead End Towers, Downcomers, and Switches
- Transmission Breakaway Towers
- Makeup Demineralized Water Tanks

For each of the important-to-reliability NSR SSCs above, a detailed analysis was conducted to identify the probable failure modes and the likely extent of damage that might be sustained during a SONGS review level earthquake. Table 4-3 provides a summary of the failure modes identified for each SSC.

Table 4-3 Components that Have Capacities Below SONGS Review Level Earthquake

Component	Location	Failure Mode
Main, Unit Auxiliary, and Reserve Auxiliary Transformers		
Main Transformer	Yard	Anchorage Failure
Main Transformer Phase Bus	Yard	Expansion Joint Boot Damage
Main Transformer 230 kV Bushings	Yard - Main Transformers	Shifting of Porcelain
Main Transformer Surge Arresters	Yard - Main Transformers	Porcelain Failure
Main Transformer Radiator Headers	Yard - Main Transformers	Gasket Joint Failure
Unit Auxiliary Transformers	Yard	Anchorage Failure
Reserve Auxiliary Transformers	Yard	Anchorage Failure
Reserve Auxiliary Transformers 230 kV Bushings	Yard – Reserve Auxiliary Transformers	Shifting of Porcelain
Reserve Auxiliary Transformer Surge Arresters	Yard - Reserve Auxiliary Transformers	Porcelain Failure
Reserve Auxiliary Transformers Radiator Headers	Yard - Reserve Auxiliary and Unit Auxiliary Transformers	Gasket Joint Failure
Line Dead End Towers, Downcomers, and Switches		
Line Dead End Towers	Switchyard	Base Plate Connection Weld Cracking
Downcomers	Switchyard	Tether Post Anchorage Failure
Disconnect Switches	Switchyard	Switch Misalignment and Base Bearing Deformation
Transmission Breakaway Towers		
Main Transformer - Transmission Breakaway Tower	Yard - Main Transformers	Base Plate Connection Weld Cracking
Reserve Auxiliary Transformers - Transmission Breakaway Tower	Yard – Reserve Auxiliary Transformers	Base Plate Connection Weld Cracking
Tall Pedestal Mounted Disconnect Switches	Yard – Reserve Auxiliary Transformer	Switch Misalignment, Base Bearing Deformation, and Porcelain Failure
Makeup Demineralized Water Tanks		
Makeup Demineralized Water Tanks	South Tank Area	Base Uplift and Shell Buckling

4.2.2.1 Main, Auxiliary, and Reserve Auxiliary Transformers

The output of the 22 kV generators is routed to the main transformer of each unit using phase bus structures that were designed using the 0.2g NSR seismic design criterion. Earthquake joints were incorporated in the phase bus design, but the sealing boots are expected to pull apart in an earthquake. Because the phase bus is air cooled, the loss of the joint seals will reduce the current capacity in the phase bus until it is repaired.

The anchorage of the main transformers was also designed for the 0.2g NSR seismic design criterion. An analysis of the anchorage load path using American Concrete Institute (ACI) 349 criteria indicates that the anchorage capacity is below the SONGS review level earthquake. The supports of the conservator tank mounted on the main transformer are judged to be vulnerable at the same earthquake level.

A similar anchorage analysis was performed for the smaller auxiliary transformers and the reserve auxiliary transformers, and results indicated that the anchorage capacities of the transformers are less than the SONGS review level earthquake.

Past earthquake experience indicates that the transformer oil radiator piping has the potential to leak. In addition, the transformer bushings may shift and the mounted surge arresters may fail. Fragility data compiled by California utilities (Eidinger, et al, 1995) indicate that capacities are below the SONGS review level earthquake.

The disconnect switches supported on the tall pedestal frames adjacent to the reserve auxiliary transformers may also become misaligned. In addition, the base bearings may deform and the porcelain may become damaged.

4.2.2.2 Line Dead End Towers, Downcomers, and Switches (Switchyard) and Transmission Breakaway Towers (Yard)

In the SONGS switchyard, the 0.5g SCE transmission facility (1975) seismic design criterion was utilized for the anchorage of the power apparatus and design of the support structures.

The SONGS line dead end towers, as well as the transmission getaway towers located in the plant yard adjacent to the transformers, use the same configuration and fabricated tube type that was extensively damaged in the 1994 Northridge earthquake at the SCE Pardee Substation, which was designed at approximately the same time as SONGS. The Pardee dead end towers experienced two basic failure modes: 1) the flexibility of the towers contributed to the lateral displacement of the suspended potential transformers (PTs) incorporated in the conductor downcomers that resulted in the failure of the downcomer post supports and also caused damage to the adjacent disconnect switches; and 2) weld cracking that occurred in the base plate connection of the tower tubular sections. The weld failures were similar to the unanticipated brittle weld fractures that occurred in many building connections subjected to the 1994 Northridge earthquake. The cause of such weld cracking was determined to not be a design issue but rather the result of fabrication issues, such as the lack of control of base metal properties, the use of weld filler materials with low toughness, and the lack of proper preheat and welding procedures (FEMA, 2000). The towers were designed for 0.5g loading; however, the tower base connection weld detail had a unique configuration (i.e., a full penetration weld of a tubular structural member to a very thick base plate) which produced welds that were susceptible to brittle cracking. This unique configuration was only specific to the tower base welded connections and was not present in any other location at SONGS. Furthermore, the rest of the tower structure behaved as expected in conformance with the design. The Pardee towers were still functional following the Northridge earthquake but required re-welding of the base details and the addition of gusset plates to the base plate connections. The measured ground motion at the Pardee substation was used to provide the basis for the capacity evaluation of the line dead end towers, the transmission breakaway towers, the conductor downcomers and suspended PTs, and the adjacent disconnect switches.

4.2.2.3 Makeup Demineralized Water Tanks

The makeup demineralized water tanks consist of unanchored 535,000 gallon tanks that were designed in accordance with the American Petroleum Institute (API) Standard 620 seismic design criteria. These types of tanks have historically been damaged due to base uplift and shell buckling that would ultimately lead to a loss of contents.

4.2.3 SSCs Requiring Additional Analysis for Seismic Capacity Assessment

4.2.3.1 Offshore Discharge Conduits

The offshore discharge conduits were identified as potentially unable to withstand the SONGS review level earthquake; thus, a detailed analysis is required. Some of the backfill used for the discharge conduits was sand. Thus, soil liquefaction of the backfill is possible during an earthquake, which could cause the discharge conduits to become buoyant and come apart at the joints. A detailed analysis is in progress to evaluate the capacity of the offshore discharge conduits to withstand a SONGS review level earthquake.

4.3 Repair and Replacement Duration Estimates

Table 4-4 of this study presents conceptual repair / replacement time duration estimates to restore function of the important-to-reliability NSR SSCs that may sustain damage during a SONGS review level earthquake. Procurement, design, and construction times were evaluated and provided by SCE. The conceptual repair / replacement time duration estimates assumed the following:

- Only one unit is required to be put back to service following a SONGS review level earthquake as the SCE transmission system is designed to operate reliably with one SONGS unit out-of-service.
- When groups of common SSCs were considered, they were assumed to have a 50% failure rate. Based on the recovery efforts for power system damage caused by prior earthquakes (Eidinger, et al, 1995), a failure rate of 40 to 50% for a 230 kV substation power apparatus has been observed for ground motion levels having PGA values within the range 0.4 to 0.5g. Thus, a 50% failure rate is an upper bound estimate for earthquake damage to yard and switchyard equipment due to a SONGS review level earthquake.
- The other unit can be a source for replacement parts, which may eliminate the need of procurement for some parts that have a long lead time.

Table 4-4 Conceptual Repair and Replacement Estimates

Repair / Replacement Area	Component	Estimated Time to Restore Function (Months)
Plant Yard Electrical Components	Main, Unit Auxiliary, and Reserve Auxiliary Transformer • Phase Bus • 230 kV Bushings • Surge Arresters • Radiator Headers • Anchorages	≤ 3
	Transmission Breakaway Towers • Tower Bases • Tall Pedestal Mounted Disconnect Switches	
Switchyard Components	Line Dead End Towers Base Plates	≤ 3
	Downcomers	
	Disconnect Switches	
Makeup Demineralized Water Tanks	-	≤ 4

4.3.1 Plant Yard Electrical Components

The scope of work to repair / replace the plant yard electrical components includes:

- Repair of 50% of the transformer anchorages (including anchor bolt replacements, concrete repairs, and weld repairs).
- Replacement of 50% of the transformer bushings and arresters.
- Repair of 50% of the transformer radiator oil piping supporting the radiators.
- Repair of the conservator tank supports.
- Repair of 50% of the isophase joints (the outer casing joints will need to be resealed).
- Repair of 50% of the breakaway transmission tower base plate connections.

This work is estimated to take 3 months.

4.3.2 Switchyard Components

The scope of work to repair / replace the switchyard components includes:

- Repair of the base plate weld connection on 50% of the dead end transmission towers.
- Repair of 50% of the downcomer tethers.
- Replacement of 50% of the disconnect switch bases.

This work is estimated to take 3 months.

4.3.3 Makeup Demineralized Water Tanks

There are three 535,000 gallon makeup demineralized water tanks that, if damaged during an earthquake, will require replacement. The scope of this work includes:

- Demolition.
- Removal of the existing tanks.
- Installation of a new foundation.
- Supply and installation of new tanks.
- Replacement of the connection pipes.

A complete replacement of the tanks is estimated to take 4 months.

4.4 Mitigation Plans

The initial repair / replacement estimates have not identified any component that could cause a prolonged outage due to a seismic event. Therefore, mitigation plans were not developed.

5. CONCLUSIONS

This study has not identified any important-to-reliability NSR SSCs that could be the cause of a prolonged outage due to a seismic event. The offshore discharge conduits are currently undergoing further specialized evaluations (soil laboratory testing and time history soil structure interaction analyses) to assess their seismic capacity.

6. REFERENCES

10CFR100AppA, Current, Seismic and Geologic Siting Criteria for Nuclear Power Plant, Title 10, Code of Federal Regulations, Part 100, Appendix A.

CEC, 2008, AB 1632 Assessment of California's Operating Nuclear Plants, prepared by California Energy Commission, CEC-100-2008-005-F, October 2008.

Eidinger, J. et al, 1995, High Voltage Electric Substation Performance in Earthquakes, Lifeline Earthquake Engineering, Monograph No. 6, Technical Council on Lifeline Earthquake Engineering, August 1995.

EPRI, 1994, Methodology for Developing Seismic Fragilities, prepared by Electric Power Research Institute, TR-103959, June 1994.

EPRI, 2002, Seismic Fragility Application Guide, prepared by Electric Power Research Institute, Report 1002988, December 2002.

EPRI, 2009, Seismic Fragility Applications Guide Update, prepared by Electric Power Research Institute, Report 1019200, December 2009.

FEMA, 2006, Multi-hazard Loss Estimation Methodology, Earthquake Model, prepared by Federal Emergency Management Agency, HAZUS-MH MR4, Technical Manual.

FEMA, 2000, Recommended Specifications and Quality Assurance Guidelines for Steel Moment-frame Construction for Seismic Applications, prepared by Federal Emergency Management Agency, FEMA 653.

NRC, 1987, Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46, prepared by the U.S. Nuclear Regulatory Commission, Generic Letter 87-02.

SCE, 2009, San Onofre Nuclear Generating Station, Q-List, Classification of Structures, Systems, and Components, Document 90034, Rev. 10, 2009.

SCE, 2010, San Onofre Nuclear Generating Station, Seismic Hazard Assessment Program, 2010 Probabilistic Seismic Hazard Analysis Report.

SCE, 1995, Seismic Hazard at San Onofre Nuclear Generating Station.

SQUG, 1991, Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment, prepared by Seismic Qualification Utility Group, Revision 2.

UFSAR, Current, San Onofre Nuclear Generating Station, Units 2 and 3, Current, prepared by Updated Final Safety Analysis Report.

Appendix A
List of Acronyms

AC	Alternating Current
ACI	American Concrete Institute
AEBM	Advanced Engineering Building Module
AISC	American Institute of Steel Construction
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
CEC	California Energy Commission
CBC	California Building Code
CFR	Code of Federal Regulations
CMAA	Construction Management Association of America
CO_2	Carbon Dioxide
DBE	Design-Basis Earthquake
DC	Direct Current
UFSAR	Updated Final Safety Analysis Report
EPRI	Electric Power Research Institute
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
ft	Feet
ft/sec	Feet per Second
GIP	Generic Implementation Procedure
GL	Generic Letter
H_2	Hydrogen
HAZUS	HAZards United States
HCLPF	High Confidence of Low Probability of Failure
HEI	Heat Exchange Institute
HVAC	Heating, Ventilation, and Air Conditioning
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
in.	Inch
kV	Kilovolts
kVA	Kilovolts-Amperes
MSIV	Main Steam Isolation Valves

MW	Megawatts
N_2	Nitrogen
NCO	Niigataken-Chuetsu-Oki
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSR	Non-Safety-Related
NSSS	Nuclear Steam Supply System
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
o.c.	On Center
P&ID	Process and Instrumentation
PGA	Peak Ground Acceleration
PSHA	Probabilistic Seismic Hazard Analysis
PT	Potential Transformer
SCE	Southern California Edison
SC I	Seismic Category I
SC II	Seismic Category II
SC III	Seismic Category III
SDG&E	San Diego Gas & Electric
SI II/I	Seismic Interaction II/I
SMACNA	Sheet Metal and Air Conditional Contractors' National Association
SONGS	San Onofre Nuclear Generating Station
sq. ft	Square Foot
SQUG	Seismic Qualification Utility Group
SR	Safety-Related
SSCs	Structures, Systems, and Components
UBC	Uniform Building Code
UFSAR	Updated Final Safety Analysis Report
UHS	Uniform Hazard Spectrum
USI	Unresolved Safety Issue
UL	Underwriters Laboratory
V	Volts

Appendix B
Equipment Classification List

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard(1)	Seismic Category	Location(2)	In/Out of Scope	Comment
1.2.6.3	***Lightning Protection***					
	Lightning rods, associated cables and fasteners	U.L. 96A,NFPA 78	II	C	Out	Does not affect power generation(4)
2.4 & 2.5	**HYDROLOGIC ENGINEERING/GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING (SITE-RELATED HAZARDS AND PROTECTION)**					
2.4.5.5	***Seawall***	ACI 318	II	O	Out	Does not affect power generation(4)
2.5.6	***PROBABLE MAXIMUM FLOOD (PMF) BERM AND CHANNEL***		II	M/O	Out	Does not affect power generation(4)
3.2	**CLASSIFICATION OF STRUCTURES, COMPONENTS, AND SYSTEMS**					
	Consumables (including lubricants/greases) not important to the functional capacity and performance of SR SSCs		II,III	All	Out	Readily replaced
3.4.1	***FLOOD PROTECTION***					
3.4.1.1	***Waterstops, bellows***	———	II(3)	All	Out	Designed for II/I(5); Does not affect power generation(4)
	SEISMIC CATEGORY I STRUCTURES					
3.8.3	***CONTAINMENT INTERNAL STRUCTURES***					
	Jib Crane	CMAA	II(3)	C	Out	Designed for II/I(5); Does not affect power generation(4)
4	**REACTOR**					
4.2	**REACTOR FUEL SYSTEM**					
	Neutron source	None	II	C	Out	Does not affect power generation(4)
5	**REACTOR COOLANT SYSTEM (RCS) AND CONNECTED SYSTEMS**					
5.4.1	***REACTOR COOLANT PUMPS (RCPS)***					
	Motors	NEMA MG-1	II(3)	C	In	Designed for II/I(5)
	Operating and backup oil lift pumps		II(3)	C	In	Designed for II/I(5)
	Operating and backup oil lift pump motors		II(3)	C	In	Designed for II/I(5)
	Operating and backup anti-reverse rotation device (ARRD) pumps		II(3)	C	In	Designed for II/I(5)
	Operating and backup ARRD pump motors		II(3)	C	In	Designed for II/I(5)
	RCP seal heat exchangers					
	CCW side	B31.1	II	C	In	Internal design of heat exchanger - unit anchored for II/I(5)
	Motor heat exchangers		II(3)	C	In	Designed for II/I(5)
5.4.10	***PRESSURIZER***					
	Heaters and cables	III-1	I, II	C	Out	Internal subcomponents of Category I component
5.4.11	***PRESSURIZER RELIEF DISCHARGE SYSTEM***					
	Quench tank	VIII	II(3)	C	In	Designed for II/I(5)
	Piping					
	Downstream of safety valve	B31.1	II	C	In	
	Valves associated with quench tank	B31.1	II	C	In	
6	**ENGINEERED SAFETY FEATURES**					
6.3	**SAFETY INJECTION SYSTEM**					
	Piping and valves					

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Drain lines	B31.1	II	C	Out	Does not affect power generation[4]
6.5	**FISSION PRODUCT REMOVAL AND CONTROL SYSTEMS**					
	Iodine removal system					
	Tank	III-2	II[3]	S	Out	Designed for II/I[5]; System deactivated
	Piping and valves	III-2	II[3]	C/S	Out	Designed for II/I[5]; System deactivated
	Supports	ASME	II[3]	C	Out	Designed for II/I[5]; System deactivated
7	**INSTRUMENTATION AND CONTROL SYSTEMS**					
7.5	**SR DISPLAY INSTRUMENTATION**					
7.5.1.6	***Control element assembly position indication***	IEEE 279	II	A/C	Out	Does not affect power generation[4]
7.6	**ALL OTHER INSTRUMENTATION SYSTEMS REQUIRED FOR SAFETY(Z)**					
7.6.1.7	***Anticipated Transient Without Scram (ATWS) System***					
	Diverse Scram System (DSS) Cabinet and Cabling		II[3]	A/C/P	Out	Designed for II/I[5]; Does not affect power generation[4]
	Diverse Turbine Trip (DTT) Cabling		II	A	Out	Does not affect power generation[4]
	Diverse Emergency Feedwater Actuation System (DEFAS) Cabinet and Cabling		II[3]	A/C	Out	Designed for II/I[5]; Does not affect power generation[4]
7.6.1.10	***Data Acquisition System (DAS)***		II	A	Out	Does not affect power generation[4]
7.7	**CONTROL SYSTEMS NOT REQUIRED FOR SAFETY**					
7.7.1.1.1	Boron control system		II	A/C	Out	Does not affect power generation[4]
7.7.1.2.1	Pressurizer pressure control system		II	A/C	Out	Does not affect power generation[4]
7.7.1.2.2	Pressurizer level control system		II	A/C	Out	Does not affect power generation[4]
7.7.1.3	***Feedwater control system***		II	A/C/T/ MSIV	In	
7.7.1.4	***Steam bypass control system***		II	A/C/T	In	
7.7.1.7	***In-core instrumentation system***		II	A/C	Out	Does not affect power generation[4]
7.7.1.8	***Ex-core instrumentation system (startup and control channels)***		II	A/C	Out	Does not affect power generation[4]
7.7.1.10	***Drain Down Level Monitoring System (DLMS)***					
	Cable and incontainment junction boxes		II[3]	A/C/P	Out	Designed for II/I[5]; Does not affect power generation[4]
7.7.3.1	***Refueling Water Level Instrument (RWLI)***					
	Transmitters		II	C	Out	Does not affect power generation[4]
	Indicators		II[3]	A	Out	Designed for II/I[5]; Does not affect power generation[4]
8	**ELECTRIC POWER SYSTEMS**					
8.2	**OFFSITE POWER SYSTEM**					
	Main transformers	ANSI C57.12	II	O	In	
	Auxiliary transformers	ANSI C57.12	II	O	In	
	Reserve auxiliary transformers	ANSI C57.12	II	O	In	
	220 kV disconnect switches	ANSI C57.30	II	O	In	
	Electrical equipment (220 kV switchyard)		II	O	In	

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
8.3	**ONSITE POWER SYSTEMS**					
8.3.1	***AC POWER SYSTEMS***					
	Non-class 1E equipment		II, II[3]	All	In	Designed for II/I[5]
8.3.2	***DC POWER SYSTEMS***					
	Non-class 1E equipment		II, II[3]	All	In	Designed for II/I[5]
9	**AUXILIARY SYSTEMS**					
9.1.3	***SPENT FUEL POOL COOLING AND CLEANUP SYSTEM***					
	Pumps					
	Makeup and purification pumps		II	F	Out	Does not affect power generation[4]
	Pump motors					
	Makeup and purification pump motors		II	F	Out	Does not affect power generation[4]
	Piping and valves					
	Purification subsystem					
	Other	B31.1	II	C/F/P	Out	Does not affect power generation[4]
	Makeup subsystem (backup)	B31.1	II	F/O/TK	Out	Does not affect power generation[4]
	Other					
	Ion-exchangers	VIII	II	F	Out	Does not affect power generation[4]
	Filters and strainers	VIII	II	F	Out	Does not affect power generation[4]
9.1.4	***FUEL HANDLING SYSTEM***					
	Refueling machine including auxiliary hoist	CMAA/AISC	II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Spent fuel handling machine	CMAA/AISC	II[3]	F	Out	Designed for II/I[5]; Does not affect power generation[4]
	Control element assembly change machine	AISC	II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Fuel transfer equipment set	CMAA/AISC	II	F/C	Out	Does not affect power generation[4]
	Reactor vessel head lifting rig		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Reactor internals lifting rig		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Refueling pool seal assembly		II	C	Out	Does not affect power generation[4]
	Containment polar crane	CMAA	II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Mechanical Operation					
	Bridge structure		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Trolley		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Main hoist and auxiliary hoist		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Main hoist and auxiliary hoist brakes		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Electrical Control					
	DC Power/PLC		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Trolley drive and brakes		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Bridge drive and brakes		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Main hoist and auxiliary hoist drives		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Rotate drive (main hook)		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Limit switches and resolvers		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Platforms and Jib Hoist		II[3]	C	Out	Designed for II/I[5]; Does not affect power generation[4]
	Cask handling crane	CMAA	II[3]	F	Out	Designed for II/I[5]; Does not affect power generation[4]
	New fuel elevator	CMAA/AISC	II[3]	F	Out	Designed for II/I[5]; Does not affect power generation[4]
	New fuel crane	CMAA	II[3]	F	Out	Designed for II/I[5]; Does not affect power generation[4]
9.2.3	***DEMINERALIZED WATER MAKEUP SYSTEM***					
	Demineralized water storage system	API 620	II	O	In	
9.2.5	***ULTIMATE HEAT SINK***					
	Main offshore intake structure	ACI 318	II[3]	O	In	Per UFSAR designed to withstand DBE
	Intake conduit					
	From one pipe section beyond auxiliary intake structure to main offshore intake structure	ACI 318	II[3]	O	In	Per UFSAR designed to withstand DBE
	Outfall conduit					
	West end box conduit seaward		II	O	In	
9.2.6	***CONDENSATE STORAGE FACILITY***					
	Portion associated with turbine plant					
	Condensate storage tank 2(3)T-120	API 650	II	TK	In	
	Pumps		II	O	In	
	Piping and valves	B31.1	II	O	In	
9.2.7	***NUCLEAR SERVICE WATER SYSTEM***					
	Storage tank	API 620	II	Y	In	
	Pumps and motors	HI/NEMA MG-1	II	Y	In	
	Piping and valves					
	Other	B31.1	II	A/C/F/P/S/Y	In	
9.2.8	***TURBINE PLANT COOLING WATER SYSTEM***					
	Tanks	API 620	II	O	In	
	Pumps and motors		II	O	In	
	Piping and valves	B31.1	II	T/O	In	
	Heat exchangers	VIII	II	O	In	
	Filters		II	T/O	In	
9.3.1	***COMPRESSED AIR SYSTEM***					
	Receivers	VIII	II	T	In	
	Compressors	VIII	II	T	In	
	Piping and valves					
	Other	B31.1	II	All	In	
	Aftercoolers	VIII	II	T	In	
	Dryers	VIII	II	T	In	
	Filters	VIII	II	T	In	
9.3.2	***PROCESS SAMPLING SYSTEMS***					
	Nuclear plant sampling system					

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Sample vessels	VIII	II	A	Out	Does not affect power generation[4]
	Sample blowers	VIII	II	A	Out	Does not affect power generation[4]
	Piping and valves					
	Coolant chemical and volume control system sample lines	III-2	II	A	Out	Does not affect power generation[4]
	Volume control tank sample lines up through the first normally shut valve	III-2	II	A	Out	Does not affect power generation[4]
	Waste gas system sample lines	B31.1	II	A	Out	Does not affect power generation[4]
	Other	B31.1	II	C/P/A	Out	Does not affect power generation[4]
	Coolers	VIII	II	A	Out	Does not affect power generation[4]
	Filters	VIII	II	A	Out	Does not affect power generation[4]
	Turbine plant sampling system coolers	VIII	II	A	Out	Does not affect power generation[4]
9.3.3	***EQUIPMENT AND FLOOR DRAINAGE SYSTEM***					
	Nonradioactive sump and drain systems					
	Piping and valves/pumps					
	Auxiliary building	UPC	II, III	A	Out	Does not affect power generation[4]
	Diesel generator building	UPC	II	D	Out	Does not affect power generation[4]
	East and west turbine plant area	UPC	II, III	T	Out	Does not affect power generation[4]
	North Industrial Area	UPC	II, III	Y	Out	Does not affect power generation[4]
	Radioactive sump and drain systems					
	Piping and valves/pumps					
	Component cooling water	B31.1	II	S	Out	Does not affect power generation[4]
	Containment area	B31.1	II	C	Out	Does not affect power generation[4]
	Fuel handling building	B31.1	II	F	Out	Does not affect power generation[4]
	Penetration area	B31.1	II	P	Out	Does not affect power generation[4]
	Safety injection area	B31.1	II	S	Out	Does not affect power generation[4]
	Storage tank area	B31.1	II	TK	Out	Does not affect power generation[4]
	Radwaste area	B31.1	II	A	Out	Does not affect power generation[4]
	Liner plate for safety equipment building sumps, fuel handling building sump, penetration area sump, and radwaste area sump	AISC/ASME	II	A/F/P/S	Out	Does not affect power generation[4]
9.3.4	***CHEMICAL AND VOLUME CONTROL SYSTEM***					
	Tanks					
	Volume control tank	III-2	II	A	In	
	Pumps					
	Primary plant makeup pumps		II	A	In	Needed to make power in reactor
	Motors					
	Primary plant makeup pump motors		II	A	In	Needed to make power in reactor
	Piping and valves					

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard(1)	Seismic Category	Location(2)	In/Out of Scope	Comment
	Letdown portion (from letdown backpressure control valve to radwaste diversion valve)	III-2	II	A	In	
	Volume control tank (between isolation valves)	III-2	II	A	In	
	Letdown heat exchanger					
	Purification ion-exchanger	III-2	II	A	In	
	Delithiating ion-exchanger	III-2	II	A	In	
	Deborating ion-exchanger	III-2	II	A	Out	Not required for power operation
	Purification filter	III-2	II	A	In	
9.4.1	***CONTAINMENT BUILDING VENTILATION SYSTEMS***					
9.4.1.1	***Normal Operation--Containment Building Ventilation Systems***					
	Containment normal cooling units					
	Air handling units	ARI/AMCA	II	C	In	
	Ductwork and dampers	SMACNA	II(3)	C	In	Designed for II/I(5)
	Chillers	ARI	II	A	In	
	Chilled water pumps		II	A	In	
	Compression tanks	ASME Section VIII	II	A	In	
	Piping and valves					
	Other (inside containment)	B31.1	II(3)	C	In	Designed for II/I(5)
	Other (outside containment)	B31.1	II	P/A	In	
	Strainers		II	A	In	
	Purge recirculation cleanup system					
	Purge supply units	AMCA	II	A	Out	Does not affect power generation(4)
	Purge exhaust units	AMCA	II	A	Out	Does not affect power generation(4)
	Recirculation cleanup unit (HEPA filters)	HSI-306/MIL-F-51068C	II	C	Out	Does not affect power generation(4)
	Ductwork and dampers					
	Other	ORNL-65/SMACNA	II(3)	C/P/A	Out	Designed for II/I(5); Does not affect power generation(4)
	CEDM cooling system					
	Cooling coils		II	C	In	
	Fans and motors	AMCA	II	C	In	
	Ductwork and dampers	SMACNA	II(3)	C	In	Designed for II/I(5)
	Reactor cavity cooling system					
	Fans and motors	AMCA	II	C	In	
	Ductwork and dampers	SMACNA	II(3)	C	In	Designed for II/I(5)
	MSIV enclosure and penetration area cooling system					
	Supply fans	AMCA	II	MSIV	In	Only need penetration fans, not penetration area cooling.
	Exhaust fans	AMCA	II	MSIV	Out	Does not affect power generation(4)
	Duct work and dampers	SMACNA	II	MSIV	In	
9.4.1.2	***Emergency Operation--Containment Building Ventilation Systems***					

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Hydrogen purge supply and exhaust units					
	Prefilters		II[3]	P	Out	Designed for II/I[5]; Does not affect power generation[4]
	HEPA filters	HSI-306/MIL-F-51068C	II[3]	P	Out	Designed for II/I[5]; Does not affect power generation[4]
	Charcoal filters	CS-8T	II[3]	P	Out	Designed for II/I[5]; Does not affect power generation[4]
	Electric heating coils		II	P	Out	Does not affect power generation[4]
	Fans and motors	AMCA	II	P	Out	Does not affect power generation[4]
	Ductwork					
	Other	ORNL-65/SMACNA	II[3]	C/P	Out	Designed for II/I[5]; Does not affect power generation[4]
	Valves					
	Other	B31.1	II	P	Out	Does not affect power generation[4]
	Dome air circulating units					
9.4.2	***AUXILIARY BUILDING VENTILATION SYSTEMS***					
9.4.2.1	***Normal Operation–Auxiliary Building Ventilation Systems***					
	Control room system					
	Air handling units	AMCA/ARI	II	A	In	
	Fan coil units	AMCA/ARI	II	A	In	
	Control room smoke removal fan	AMCA/NFPA	II	A	Out	Does not affect power generation[4]
	Electric duct heaters		II	A	In	
	Exhaust fans	AMCA	II	A	In	
	Transfer fans	AMCA	II	A	In	
	Ductwork and dampers	SMACNA	I, II[3]	A	In	Designed for II/I[5]
	Radwaste area system					
	Air handling units	AMCA	II	A	Out	Does not affect power generation[4]
	Exhaust fans	AMCA	II	A	Out	Does not affect power generation[4]
	CEDMCS room fan coil units		II	A	In	
	Electric duct heaters		II	A	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	A	Out	Does not affect power generation[4]
	ESF switchgear room systems					
	Air handling units	AMCA/ARI	II	A	In	
	Exhaust fans	AMCA	II	A	In	
	Electric duct heaters		II	A	In	
	Ductwork and dampers	SMACNA	II	A	In	
	Cable spreading and electrical room systems					
	Air handling units	AMCA	II	A	Out	Does not affect power generation[4]
	Return fans	AMCA	II	A	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	A	Out	Does not affect power generation[4]
	Chiller room systems					
	Air handling unit	AMCA	II	A	In	
	Exhaust fan	AMCA	II	A	In	

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Electric duct heater		II	A	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	A	In	
	Battery room systems					
	Air handling unit	AMCA	II	A	In	
	Exhaust fan	AMCA	II	A	In	
	Ductwork and dampers	SMACNA	II	A	In	
	Continuous exhaust system					
	Fans	AMCA	II	A	In	Need at least 1 of these 3 fans
	Ductwork and dampers	SMACNA	II	A/O	In	
	Plant vent stacks		II[3]	O	In	Designed for II/I[5]
9.4.3	***SUPPORT BUILDING VENTILATION SYSTEMS***					
9.4.3.1	***Fuel Handling Building Ventilation System***					
	Normal supply and exhaust system					
	Prefilters		II	F	Out	Does not affect power generation[4]
	Fans and motors	AMCA	II	F	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	F	Out	Does not affect power generation[4]
9.4.3.2	***Safety Equipment Building Ventilation System***					
	Pump room normal cooling systems					
	Fan coil units	AMCA/ARI	II	S	Out	Can operate with only Emergency Room coolers
	Heat exchanger room normal cooling systems					
	Fan coil units	AMCA/ARI	II	S	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	S	Out	Does not affect power generation[4]
	Air conditioning equipment room normal cooling system					
	Fan coil units	AMCA/ARI	II	S	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	S	Out	Does not affect power generation[4]
	Lobby area air conditioning system					
	Fan coil units	AMCA/ARI	II	S	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	S	Out	Does not affect power generation[4]
	Electric duct heaters		II	S	Out	Does not affect power generation[4]
9.4.3.3	***Turbine Building Ventilation System***					
	Steam air ejector exhaust system					
	Exhaust filtration unit	HSI-306/MIL-F-51068C	II	T	Out	Don't require to operate
	Piping and valves	ANSI B31.1	II	T	In	
	Main generator isophase bus connection enclosure ventilation system					
	Exhaust fans and motors		III	T	In	The Iso-Phase Bus has a current rating of 36.3 kA with forced cooling provided, and 21.2 kA if self-cooled.
	Ductwork	SMACNA	III	T	In	
	D7 Battery and Battery Charger Rooms (El. 56')					

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Supply Air Units	AMCA	II	T	In	
	Exhaust fans and motors	AMCA	II	T	In	
	Ductwork and dampers	SMACNA	II	T	In	
	Electric duct heaters		II	T	In	
9.4.3.4	***Diesel Generator Building Ventilation System***					
	Normal ventilation system					
	Fans and motors	AMCA	II	D	Out	Does not affect power generation[4]
	Ductwork	SMACNA	II	D	Out	Does not affect power generation[4]
9.4.3.5	***Penetration Building and Electric and Piping Tunnels Ventilation System***					
	Penetration building system					
	Air conditioning and ventilation supply units	AMCA/ARI	II	P	Out	Does not affect power generation[4]
	Prefilters		II	P	Out	Does not affect power generation[4]
	Transfer fans	AMCA	II	P	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	P	Out	Does not affect power generation[4]
	Electric and piping tunnel system					
	Ventilation supply units	AMCA	II	All	Out	Does not affect power generation[4]
	Exhaust fans	AMCA	II	All	Out	Does not affect power generation[4]
	Ductwork and dampers	SMACNA	II	All	Out	Does not affect power generation[4]
9.4.3.7	***Auxiliary Feedwater Pump Room Ventilation System***					
	Normal heating and ventilation system					
	Electrical unit heater		II	TK	Out	Does not affect power generation[4]
9.4.3.8	***Safety Equipment Building Elevator Machine Room and Condensate Storage Tank Area Ventilation System***					
	Safety Equipment Building Elevator Machine Room Ventilation System					
	Exhaust fan	AMCA	II	S	Out	Does not affect power generation[4]
	Condensate Storage Tank Area Ventilation System					
	Electrical unit heater		II	TK	Out	Does not affect power generation[4]
9.5.1	***FIRE PROTECTION SYSTEM***					
	Water System					
	Tanks	NFPA/API 650	II	O	In	Required by the Technical Specifications
	Pumps and motors	NFPA/NMR	II	O	In	
	Piping and valves					
	Suppression system	NFPA	II	All	In	
	Gaseous system (Halon)	NFPA/VIII	II	A	In	Not needed to start
	Gaseous system (CO_2)					
	Other	NFPA	II	T/O	In	Not needed to start
	Fire Barrier					
	Rated doors, walls	ACI-318, NFPA	II, III	A/C/D/F/MS IV/S/T/TK	Out	Does not affect power generation[4]

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Penetration seals	ASTM E119	II,III	A/C/D/F/MS IV/S/T/TK	Out	Does not affect power generation[4]
	Fire resistant wrap	NFPA/ASTM E119	II[3]	A/C/D/F/S/T /TK	Out	Designed for II/I[5]; Does not affect power generation[4]
	Conduits and cable trays		I, II[3]	All	Out	Designed for II/I[5]; Does not affect power generation[4]
	Fire dampers	NFPA	II, III	A/C/D/F/S/T /TK	Out	Does not affect power generation[4]
	Fluid diversion structure (RCP lube oil collection system)	ANSI B31.1, ASME VIII, and AISC	II	C	Out	Designed for II/I[5]; Does not affect power generation[4]
9.5.2	***COMMUNICATIONS SYSTEM***					
	Reservoir Thunderbolt Siren	FCC	II	O	Out	Does not affect power generation[4]
9.5.3	***LIGHTING SYSTEMS***					
	Lighting components integral to control room ceiling		II[3]	A	Out	Designed for II/I[5]; Does not affect power generation[4]
	Control room emergency lights		II[3]	A	Out	Designed for II/I[5]; Does not affect power generation[4]
	8-hour emergency lights	UL924, IES	II/III	All	Out	Does not affect power generation[4]
9.5.6	***DIESEL GENERATOR STARTING AIR SYSTEM***					
	Compressors		II	D	Out	Does not affect power generation[4]
	Air dryers		II	D	Out	Does not affect power generation[4]
	Filters, intake		II	D	Out	Does not affect power generation[4]
10	**STEAM AND POWER CONVERSION SYSTEM**					
10.2	**TURBINE-GENERATOR**					
	Turbine: High, low pressure		II	T	In	
	Control and protective valve system	B31.1	II	T	In	
	Turbine drains	B31.1	II	T	In	
	Exhaust hood spray system	B31.1	II	T	In	
	Lube oil system					
	Components	VIII	II	T	In	
	Turbine control system		II	T	In	Per high pressure and low pressure valve
	Turbine control panel		II	T	In	
	Turbine supervisory system		II	T	In	
	Turbine protective devices		II	T	In	
	Turbine overspeed protection	IEEE 279	II	A/T	In	
	Turbine monitoring equipment		II	T	In	
	Turbine support accessories		II	T	In	
	Generator		II	T	In	
	Seal oil system	VIII	II	T	In	
	Hydrogen coolers	VIII	II	T	In	
	Generator H_2/CO_2 system		II	T	In	
	Stator water system	VIII	II	T	In	

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Exciter switchgear and voltage regulator		II	T	In	
	Exciter		II	T	In	
	Piping and valves	B31.1	II		In	
	Turbine gantry crane	CMAA	II	T/O	Out	Does not affect power generation[4]
10.3	**MAIN STEAM SUPPLY SYSTEM**					
	Steam traps		II	S/T/TK	Out	Does not affect power generation[4]
	Reheaters	VIII	II	T	In	
	Moisture separator-reheater drain tanks	VIII	II	T	In	
	Main steam tube bundle drain tanks	VIII	II	T	In	
	Bled steam tube bundle drain tanks	VIII	II	T	In	
	Y-strainers	VIII	II	T	In	
	Piping and valves					
	Other	B31.1	II	MSIV/T	In	
10.4.1	***MAIN CONDENSER***					
	Main condensers	HEI	II	T	In	
	Vent and drain system	B31.1	II	T	In	
	Piping and valves	B31.1	II	T	In	
10.4.2	***MAIN CONDENSER EVACUATION SYSTEM***					
	Seal water heat exchanger	VIII/HEI	II	T	In	
	Air ejector condenser	VIII	II	T	In	
	Air ejectors	VIII/HEI	II	T	In	
	Condenser vacuum pump	VIII	II	T	In	
	Seal water pumps		II	T	In	
	Separator tanks		II	T	In	
10.4.3	***TURBINE GLAND SEALING SYSTEM***					
	Gland steam condenser exhaust fan		II	T	In	
	Gland steam condenser	VIII	II	T	In	
	Piping and valves	B31.1	II	T	In	
10.4.4	***TURBINE BYPASS SYSTEM***					
	Piping and valves	B31.1	II	T	In	
10.4.5	***CIRCULATING WATER SYSTEM***					
	Pumps and motors		II	IN	In	
	Piping and valves	B31.1	II	IN	In	
	Expansion joints		II	IN	In	
	Strainers	VIII	II	IN	In	
	Traveling rakes and bar screens		II	IN	In	
	Gates #4, 5, and 6		II[3]	IN	In	Designed for II/I[5]
	Gate operators and accessory equipment		II[3]	IN	In	Designed for II/I[5]
10.4.6	***CONDENSATE CLEANUP SYSTEM (FULL FLOW CONDENSATE POLISHING DEMINERALIZER)***					

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard(1)	Seismic Category	Location(2)	In/Out of Scope	Comment
	Seal water heat exchangers	VIII	II	FFCPD	Out	Does not affect power generation(4)
	Tanks	VIII	II	FFCPD/O	Out	Does not affect power generation(4)
	Pumps		II	FFCPD/O	Out	Does not affect power generation(4)
	Polishers					
	Fines filter		II	FFCPD	Out	Does not affect power generation(4)
	Sample coolers		II	O	Out	Does not affect power generation(4)
	Air blower package		II	FFCPD	Out	Does not affect power generation(4)
	Resin hopper		II	FFCPD	Out	Does not affect power generation(4)
	Piping and valves	ANSI B31.1	II	FFCPD/O	Out	Does not affect power generation(4)
10.4.7	***CONDENSATE AND FEEDWATER SYSTEM (ALSO REFER TO CONDENSATE STORAGE SYSTEM, SUBSECTION 9.2.6)***					
	Tanks					
	Heater drain tanks	VIII	II	T	In	
	Feedwater pump seal drain tanks	VIII	II	T	In	
	Feedwater pump turbine drain tanks	VIII	II	T	In	
	Pumps and motors					
	Condensate transfer pumps		II	T	In	
	Condensate pumps		II	T	In	
	Heater drain pumps		II	T	In	
	Feedwater pumps		II	T	In	
	Feedwater pump turbine drain pumps		II	T	In	
	Piping and valves					
	Other	B31.1	II	T	In	
	Feedwater heaters	VIII	II	T	In	
10.4.8	***STEAM GENERATOR BLOWDOWN SYSTEM***					
	Tanks					
	Blowdown flash tank	VIII	II	T	Out	Can bypass tank
	Demineralizer acid storage tanks	VIII	II	T	Out	Not used
	Demineralizer caustic storage tanks	VIII	II	T	Out	Not used
	Pumps and motors					
	Acid metering pumps	VIII	II	T	Out	Not used
	Caustic metering pumps	VIII	II	T	Out	Not used
	Piping and valves					
	Other	B31.1	II	MSIV/T	In	
	Blowdown heat exchanger	VIII	II	T	In	
	Demineralizer hot water heat exchanger	VIII	II	T	Out	Not used
	Mixed bed demineralizers	VIII	II	T	Out	Not used
10.4.10	***TURBINE PLANT CHEMICAL ADDITION SYSTEM***					
	Pumps and motors					
	Amine feed pumps		II	T	In	

Equipment Classification

UFSAR Section	Principal Component	Principal Design and Construction Code or Standard[1]	Seismic Category	Location[2]	In/Out of Scope	Comment
	Piping and valves	B31.1	II	T	In	
11	**RADIOACTIVE WASTE MANAGEMENT SYSTEMS**					
11.2	**LIQUID WASTE MANAGEMENT SYSTEM (COOLANT RADWASTE, MISCELLANEOUS LIQUID WASTE, AND BORIC ACID RECYCLE SYSTEMS)**					
	Tanks, atmospheric (except primary plant makeup storage tank)	API 650	II	A	Out	Does not affect power generation[4]
	Tanks, pressure	VIII	II	C	Out	Does not affect power generation[4]
	Pumps and motors		II	A	Out	Does not affect power generation[4]
	Piping and valves					
	Other	B31.1	II	A/C/P	Out	Does not affect power generation[4]
	Ion-exchangers	VIII	II	A	Out	Does not affect power generation[4]
	Filters and strainers	VIII	II	A	Out	Does not affect power generation[4]
	Tank heaters	NEMA 4	II	A	Out	Does not affect power generation[4]
	Gas strippers	VIII	II	A	Out	Does not affect power generation[4]
	Evaporators					
	Process and cooling water side	III-3	II	A	Out	Does not affect power generation[4]
	Steam side	VIII	II	A	Out	Does not affect power generation[4]
11.3	**GASEOUS WASTE MANAGEMENT SYSTEM (WASTE GAS SYSTEM)**					
	Tanks					
	Surge tank	VIII	II	A	Out	Does not affect power generation[4]
	Decay tanks	VIII	II	A	Out	Does not affect power generation[4]
	Pumps and motors					
	Surge tank drain pump		II	A	Out	Does not affect power generation[4]
	Compressor assembly					
	Compressor	VIII	II	A	Out	Does not affect power generation[4]
	Motor		II[3]	A	Out	Designed for II/I[5]; Does not affect power generation[4]
	Piping and valves					
	Waste gas surge tank drain	B31.1	II	A	Out	Does not affect power generation[4]
	Waste gas discharge header	B31.1	II	A	Out	Does not affect power generation[4]
	Vent gas collection header	B31.1	II	A	Out	Does not affect power generation[4]
	Other	B31.1	II	A/C/P	Out	Does not affect power generation[4]
	Y-strainer	VIII	II	A	Out	Does not affect power generation[4]
11.5	**PROCESS AND EFFLUENT RADIOLOGICAL MONITORING AND SAMPLE SYSTEMS**					
	All other airborne radiation monitors		II	A/T	Out	Does not affect power generation[4]
	Liquid radiation monitors	VIII	II	A/P/T/Y	Out	Does not affect power generation[4]
	Sample piping and tubing	B31.1	II	T	Out	Does not affect power generation[4]
	Normal sample lab isolation monitor	IEEE 279/323/338/383	II	A	Out	Does not affect power generation[4]
12	**RADIATION PROTECTION**					
12.3	**AREA RADIATION MONITORING SYSTEM**					
	Area radiation monitors		II	A/C/F/S	Out	Does not affect power generation[4]

Explanation:

1. Principal Design and Construction Code or Standard includes: ACI = America Concrete Institute, AISC = American Institute of Steel Construction, AMCA = Air Movement and Control Association, ANSI = American National Standards Institute, ASME = American Society of Mechanical Engineers, CMAA = Construction Management Association of America, FCC = Federal Communications Commission, HEI = Heat Exchange Institute, IEEE = Institute of Electrical and Electronics Engineers, IES = Illuminating Engineering Society, ORNL = Oak Ridge National Laboratory, NEMA = National Electrical Manufacturers Association, NFPA = National Fire Protection Association, SMACNA = Sheet Metal and Air Conditional Contractors' National Association, and U.L. = Underwriters Laboratory,
2. The location was assigned to one of the following categories: A = Auxiliary Building, C = Containment Building, D = Diesel Generator Building, F = Fuel Handling Building, FFCPD = Full Flow Condensate Polishing Demineralizer Area, IN = Intake Structure, MSIV = Main Steam Isolation Valve Area, O = Outdoor Yard Area, P = Penetration Area, S = Safety Equipment Building, T = Turbine Building, TK = Tank Building
3. Signifies that the Category II component is anchored for the DBE loading to prevent interaction with Category I components.
4. Signifies that the Category II component may be need to be functional during power operation but does not affect power generation capability and is easily replaceable / repairable.
5. II/I = seismic interaction II/I

Appendix C
Electrical Equipment List

Electrical Equipment							
Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2XM	Main Transformer	Power Transformer 22 kV/220 kV	Anchorage Capacity	Yard	No	No	Yes
	Surge Arrester	Mounted Subcomponent	Porcelain Capacity	Yard	No	No	No
	Bushings	Mounted Subcomponent	Porcelain Shift	Yard	No	No	No
	Radiators	Mounted Subcomponent	Not Braced	Yard	No	No	Yes
	Conservator	Mounted Subcomponent	Weak Lateral Load Path	Yard	No	No	Yes
	Sudden Pressure Relay	Mounted Subcomponent	Recoverable if Tripped	Yard	Yes	Yes	Yes
	Intermediate Structure	Tower	Pardee Type Structure-II/I Design	Yard	Yes	No	Yes
	Dead End Structure	Tower	Pardee Type Structure-II/I Design	Yard	Yes	No	Yes
2XU1	Unit Auxiliary Transformer	Power Transformer 22 kV/4.16 kV	Anchorage Capacity	Yard	No	No	Yes
2XU2	Unit Auxiliary Transformer	Power Transformer 22 kV/6.9 kV	Anchorage Capacity	Yard	No	No	Yes
	Radiators	Mounted Subcomponent	Not Braced	Yard	No	No	Yes
	Sudden Pressure Relay	Mounted Subcomponent	Recoverable If Tripped	Yard	Yes	Yes	Yes
IPB	Isophase Bus	Bus 22 kV	Outer Casing Boot	Yard	No	No	Yes
	Isophase Bus Cooling Unit			Yard	Yes	Yes	Yes
2XR1	Reserve Auxiliary Transformer	Power Transformer 220 kV/4.16 kV	Anchorage Capacity	Yard	No	No	Yes
2XR2	Reserve Auxiliary Transformer	Power Transformer 220 kV/4.16 kV	Anchorage Capacity	Yard	No	No	Yes
2XR3	Reserve Auxiliary Transformer	Power Transformer 220 kV/6.9 kV	Anchorage Capacity	Yard	No	No	Yes
	Surge Arresters	Mounted Subcomponent	Porcelain Capacity	Yard	No	No	No
	Bushings	Mounted Subcomponent	Porcelain Shift	Yard	No	No	No
	Radiators	Mounted Subcomponent	Not Braced	Yard	No	No	Yes
	Sudden Pressure Relay	Mounted Subcomponent	Recoverable If Tripped	Yard	Yes	Yes	Yes
	Dead End Structure	Tower	Pardee Type Structure-II/I Design	Yard	Yes	No	No
	Electrical Tunnel			Yard	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2A01	Bus 2A01	Medium Voltage Switchgear 6.9 kV	Reactor Coolant Pumps	45' Penetration Building	Yes	Yes	Yes
2A02	Bus 2A02	Medium Voltage Switchgear 6.9 kV	Reactor Coolant Pumps	63' Penetration Building	Yes	Yes	Yes
2XR1DSA03	Disconnect Switch	Medium Voltage Switchgear 4.16 kV			Yes	Yes	Yes
2XR1DSA08	Disconnect Switch	Medium Voltage Switchgear 4.16 kV			Yes	Yes	Yes
2XR2DSA07	Disconnect Switch	Medium Voltage Switchgear 4.16 kV			Yes	Yes	Yes
2XR2DSA09	Disconnect Switch	Medium Voltage Switchgear 4.16 kV			Yes	Yes	Yes
2A03	Bus 2A03	Medium Voltage Switchgear 4.16 kV		30' Turbine Building	Yes	Yes	Yes
2A07	Bus 2A07	Medium Voltage Switchgear 4.16 kV		30' Turbine Building	Yes	Yes	Yes
2A08	Bus 2A08	Medium Voltage Switchgear 4.16 kV		85' Control Building	Yes	Yes	Yes
2A09	Bus 2A09	Medium Voltage Switchgear 4.16 kV		85' Control Building	Yes	Yes	Yes
2B01	2B01 Bus	Low Voltage Switchgear 480 V			Yes	Yes	Yes
2B01X	Loadcenter Transformer	Transformer 4.16 kV/480 V			Yes	Yes	Yes
2B02	2B02 Bus	Low Voltage Switchgear 480 V	Pressurizer Heaters		Yes	Yes	Yes
2B02X	Loadcenter Transformer	Transformer 4.16 kV/480 V			Yes	Yes	Yes
2B03	2B03 Bus	Low Voltage Switchgear 480 V		30' Turbine Building	Yes	Yes	Yes
2B03X	Loadcenter Transformer	Transformer 4.16 kV/480 V		30' Turbine Building	Yes	Yes	Yes
2B07	2B07 Bus	Low Voltage Switchgear 480 V		30' Turbine Building	Yes	Yes	Yes
2B07X	Loadcenter Transformer	Transformer 4.16 kV/480 V	SCE Switchyard Relay House	30' Turbine Building	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2B08	2B08 Bus	Low Voltage Switchgear 480 V	Pressurizer Heaters		Yes	Yes	Yes
2B08X	Loadcenter Transformer	Transformer 4.16 kV/480 V			Yes	Yes	Yes
2B09	2B09 Bus	Low Voltage Switchgear 480 V			Yes	Yes	Yes
2B09X	Loadcenter Transformer	Transformer 4.16 kV/480 V			Yes	Yes	Yes
2B10	2B10 Bus	Low Voltage Switchgear 480 V		85' Control Building	Yes	Yes	Yes
2B11	2B11 Bus	Low Voltage Switchgear 480 V		30' Turbine Building	Yes	Yes	Yes
2B11X	Loadcenter Transformer	Transformer 4.16 kV/480 V		30' Turbine Building	Yes	Yes	Yes
2B12	2B12 Bus	Low Voltage Switchgear 480 V		30' Turbine Building	Yes	Yes	Yes
2B12X	Loadcenter Transformer	Transformer 4.16 kV/480 V		30' Turbine Building	Yes	Yes	Yes
2B13	2B13 Bus	Low Voltage Switchgear 480 V		30' Turbine Building	Yes	Yes	Yes
2B13X	Loadcenter Transformer	Transformer 4.16 kV/480 V		30' Turbine Building	Yes	Yes	Yes
2B14	2B14 Bus	Low Voltage Switchgear 480 V		30' Turbine Building	Yes	Yes	Yes
2B14X	Loadcenter Transformer	Transformer 4.16 kV/480 V		30' Turbine Building	Yes	Yes	Yes
2B15	2B15 Bus	Low Voltage Switchgear 480 V		85' Control Building	Yes	Yes	Yes
2B15X	Loadcenter Transformer	Transformer 4.16 kV/480 V		85' Control Building	Yes	Yes	Yes
2B16	2B16 Bus	Low Voltage Switchgear 480 V		85' Control Building	Yes	Yes	Yes
2B16X	Loadcenter Transformer	Transformer 4.16 kV/480 V		85' Control Building	Yes	Yes	Yes
2B18	2B18 Bus	Low Voltage Switchgear 480 V			Yes	Yes	Yes
2B18X	Loadcenter Transformer	Transformer 4.16 kV/480 V			Yes	Yes	Yes

Electrical Equipment							
Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2B19	2B19 Bus	Low Voltage Switchgear 480 V		HFMUD	Yes	Yes	Yes
2B24	2B24 Bus	Low Voltage Switchgear 480 V		50' Control Building	Yes	Yes	Yes
2B26	2B26 Bus	Low Voltage Switchgear 480 V		50' Control Building	Yes	Yes	Yes
2/3B58	2/3B58 Bus	Low Voltage Switchgear 480 V		N Industrial Area	Yes	Yes	Yes
2B1611BP	Panel	480 V		56' Control Building	Yes	Yes	Yes
B10X-A	Loadcenter Transformer	Transformer 4.16 kV/480 V			Yes	Yes	Yes
L01X-A	Transformer	Transformer 4.16 kV/208V/120 V	Lighting		Yes	Yes	Yes
L02X-A	Transformer	Transformer 4.16 kV/208V/120 V	Lighting		Yes	Yes	Yes
B10	B10 Bus	Low Voltage Switchgear 480 V	Common Unit Bus		Yes	Yes	Yes
L01	L01 Bus	Low Voltage Switchgear 480 V	Common Unit Lighting Bus		Yes	Yes	Yes
L02	L02 Bus	Low Voltage Switchgear 480 V	Common Unit Lighting Bus		Yes	Yes	Yes
2BX	Motor Control Center	Motor Control Center		50' Control Building	Yes	Yes	Yes
2BA	Motor Control Center	Motor Control Center		45' Penetration Area	Yes	Yes	Yes
2BC	Motor Control Center	Motor Control Center		34' Turbine Building	Yes	Yes	Yes
2BDX	Motor Control Center	Motor Control Center		30' Diesel Generator	Yes	Yes	Yes
2BMX	Motor Control Center	Motor Control Center		30' Turbine Building	Yes	Yes	Yes
2BLX	Motor Control Center	Motor Control Center		30' Turbine Building	Yes	Yes	Yes
2BV	Motor Control Center	Motor Control Center		34' Turbine Building	Yes	Yes	Yes
2BF	Motor Control Center	Motor Control Center		30' Aux FW	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2BB	Motor Control Center	Motor Control Center		7' Turbine Building	Yes	Yes	Yes
2BK	Motor Control Center	Motor Control Center		7' Intake Structure	Yes	Yes	Yes
2BL	Motor Control Center	Motor Control Center		30' Turbine Building	Yes	Yes	Yes
2BDX	Motor Control Center	Motor Control Center		30' Diesel Generator	Yes	Yes	Yes
2BHX	Motor Control Center	Motor Control Center		30' Aux FW	Yes	Yes	Yes
2BW	Motor Control Center	Motor Control Center		7' Turbine Building	Yes	Yes	Yes
2BI	Motor Control Center	Motor Control Center		34' Turbine Building	Yes	Yes	Yes
2BM	Motor Control Center	Motor Control Center		7' Turbine Building	Yes	Yes	Yes
DM	Motor Control Center	Motor Control Center			Yes	Yes	Yes
2BRC	Motor Control Center	Motor Control Center		34' Turbine Building	Yes	Yes	Yes
2BN	Motor Control Center	Motor Control Center		63' Penetration Area	Yes	Yes	Yes
2Q086	Motor Control Center	Motor Control Center			Yes	Yes	Yes
BO	Motor Control Center	Motor Control Center	Common Between Units		Yes	Yes	Yes
BP	Motor Control Center	Motor Control Center	Common Between Units		Yes	Yes	Yes
BG	Motor Control Center	Motor Control Center	Common Between Units		Yes	Yes	Yes
BT	Motor Control Center	Motor Control Center	Common Between Units		Yes	Yes	Yes
BU	Motor Control Center	Motor Control Center	Common Between Units		Yes	Yes	Yes
BQ	Motor Control Center	Motor Control Center	Common Between Units	50' Control Building	Yes	Yes	Yes
BRD	Motor Control Center	Motor Control Center		HFMUD	Yes	Yes	Yes
BRE	Motor Control Center	Motor Control Center		HFMUD	Yes	Yes	Yes
BS	Motor Control Center	Motor Control Center	Common Between Units	50' Control Building	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2T011	Transformer	Transformer 4.16 kV/120 V	UPS		Yes	Yes	Yes
2T014	Transformer	Transformer 4.16 kV/120 V	UPS		Yes	Yes	Yes
2B011	125 V Battery Set		Normal 125 V		Yes	Yes	Yes
2B005	125 V Battery Charger				Yes	Yes	Yes
2D1	125 V Distribution Switchboard			50' Room 310A	Yes	Yes	Yes
2D1P1	125 V Distribution Switchboard			50' Room 310A	Yes	Yes	Yes
2D2	125 V Distribution Switchboard			50' Room 310D	Yes	Yes	Yes
2D2P1	125 V Distribution Switchboard			50' Room 310D	Yes	Yes	Yes
2D3	125 V Distribution Switchboard			50' Room 310B	Yes	Yes	Yes
2D3P1	125 V Distribution Switchboard			50' Room 310B	Yes	Yes	Yes
2D4	125 V Distribution Switchboard			50' Room 310C	Yes	Yes	Yes
2D4P1	125 V Distribution Switchboard			50' Room 310C	Yes	Yes	Yes
2D5	125 V Distribution Switchboard				Yes	Yes	Yes
2Y005	120 V Inverter				Yes	Yes	Yes
2D5P1	125 V Distribution Panel				Yes	Yes	Yes
2D5P2	125 V Distribution Panel				Yes	Yes	Yes
2D5P3	125 V Distribution Panel				Yes	Yes	Yes
2D5P4	125 V Distribution Panel				Yes	Yes	Yes
BA1	125 V Battery Set		Switchyard House		Yes	Yes	Yes
BA2	125 V Battery Set		Switchyard House		Yes	Yes	Yes
BC1	125 V Battery Charger		Switchyard House		Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
BC2	125 V Battery Charger		Switchyard House		Yes	Yes	Yes
DP1	125 V Distribution Switchboard		Switchyard House		Yes	Yes	Yes
DP2	125 V Distribution Panel		Switchyard House		Yes	Yes	Yes
DP3	Distr SWBD		Switchyard House		Yes	Yes	Yes
DP4	Distr Panel		Switchyard House		Yes	Yes	Yes
2B012	250 V Battery Set		Turbine Oil Pressure		Yes	Yes	Yes
2B006A	250 V Battery Charger				Yes	Yes	Yes
2B006	250 V Battery Charger		Standby		Yes	Yes	Yes
2D6	250 V Distribution Switchboard				Yes	Yes	Yes
2B019	250 V Battery Set		Turbine Oil Pressure		Yes	Yes	Yes
2B018E	250 V Battery Charger				Yes	Yes	Yes
2B018W	250 V Battery Charger				Yes	Yes	Yes
2D7	250 V Distribution Switchboard				Yes	Yes	Yes
2B016	250 V Battery Set		UPS		Yes	Yes	Yes
2B015	250 V Battery Charger				Yes	Yes	Yes
2Y012	120 V Inverter				Yes	Yes	Yes
2Y010	120 V Inverter			Turbine Building	Yes	Yes	Yes
2Y011	120 V Inverter			Turbine Building	Yes	Yes	Yes
2B005S	Single Cell Chargers				Yes	Yes	Yes
2B006S	Single Cell Chargers				Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2B015S	Single Cell Chargers				Yes	Yes	Yes
2B018S	Single Cell Chargers				Yes	Yes	Yes
2Q017	Q Panel			45' Penetration Building	Yes	Yes	Yes
2Q018	Q Panel			7' Turbine Building	Yes	Yes	Yes
2Q019	Q Panel			34' Turbine Building	Yes	Yes	Yes
2Q026	Q Panel			30' Turbine Building	Yes	Yes	Yes
2Q027	Q Panel			7' Turbine Building	Yes	Yes	Yes
2Q028	Q Panel			63' Penetration Building	Yes	Yes	Yes
2Q031	Q Panel			50' Control Building	Yes	Yes	Yes
2/3Q032	Q Panel			50' Control Building	Yes	Yes	Yes
2/3Q033	Q Panel			50' Control Building	Yes	Yes	Yes
2/3Q035	Q Panel			50' Control Building	Yes	Yes	Yes
2Q038	Q Panel			34' Turbine Building	Yes	Yes	Yes
2Q039	Q Panel			50' Control Building	Yes	Yes	Yes
2Q040	Q Panel			56' Turbine Building	Yes	Yes	Yes
2Q041	Q Panel			50' Control Building	Yes	Yes	Yes
2Q042	Q Panel			7' Turbine Building	Yes	Yes	Yes
2Q060	Q Panel			30' Control Building	Yes	Yes	Yes
2Q062	Q Panel			50' Control Building	Yes	Yes	Yes
2Q063	Q Panel			50' Control Building	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2Q065	Q Panel			50' Control Building	Yes	Yes	Yes
2Q069	Q Panel			7' Turbine Building	Yes	Yes	Yes
2Q070	Q Panel			7' Turbine Building	Yes	Yes	Yes
2Q071	Q Panel			50' Control Building	Yes	Yes	Yes
2/3Q072	Q Panel			50' Control Building	Yes	Yes	Yes
2Q074	Q Panel			50' Control Building	Yes	Yes	Yes
2Q075	Q Panel			50' Control Building	Yes	Yes	Yes
2/3Q076	Q Panel			70' Control Building	Yes	Yes	Yes
2Q077	Q Panel			30' Turbine Building	Yes	Yes	Yes
2Q078	Q Panel			30' Turbine Building	Yes	Yes	Yes
2Q079	Q Panel			34' Turbine Building	Yes	Yes	Yes
2Q080	Q Panel			34' Turbine Building	Yes	Yes	Yes
2Q083	Q Panel			30' Control Building	Yes	Yes	Yes
2/3Q084	Q Panel			9' Control Building	Yes	Yes	Yes
2/3Q085	Q Panel			HFMUD	Yes	Yes	Yes
2Q0611	Q Panel			7' Turbine Building	Yes	Yes	Yes
2Q0612	Q Panel			50' Control Building	Yes	Yes	Yes
2Q800N				50' Control Building	Yes	Yes	Yes
2Q800S				50' Control Building	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2Q809				9' Control Building	Yes	Yes	Yes
2Q870				70' Control Building	Yes	Yes	Yes
NE Bus	Bus Support Structures			Switchyard	Yes	Yes	Yes
NW Bus	Bus Support Structures			Switchyard	Yes	Yes	Yes
CC (6 each)	Bus Coupling Capacitor	Phase to Ground Coupling Capacitor		Switchyard	Yes	Yes	Yes
"A" Section Bus Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
Bus Ground Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
PT (6 each)	Potential Transformer			Switchyard	Yes	Yes	Yes
CCVT (6 each)	Coupling Capacitor Voltage Transformer			Switchyard	Yes	Yes	Yes
CB-4022	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
CB-6022	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
Bus Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
Line Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV	Downcomer Interaction	Switchyard	Yes	No	No
Ground Disconnect	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
CCVT (4 each)	Coupling Capacitor Voltage Transformer		Downcomer Interaction	Switchyard	No	No	No
Transmission Line Position 2	Dead End Structure		Pardee Type Structure	Switchyard	Yes	No	No

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
CB-4042	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
CB-6042	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
Bus Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
Line Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV	Downcomer Interaction	Switchyard	Yes	No	No
Ground Disconnect	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
CCVT (3 each)	Coupling Capacitor Voltage Transformer		Downcomer Interaction	Switchyard	No	No	No
CT (3 each)	Current Transformer		Downcomer Interaction	Switchyard	No	No	No
Unit 2 Overhead Line Position 4	Dead End Structures (2 each)		Pardee Type Structure	Switchyard	Yes	No	No
CB-4052	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
CB-6052	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
Bus Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
Line Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV	Downcomer Interaction	Switchyard	Yes	No	No
Ground Disconnect	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
CCVT (4 each)	Coupling Capacitor Voltage Transformer		Downcomer Interaction	Switchyard	No	No	No
Transmission Line Position 5	Dead End Structure		Pardee Type Structure	Switchyard	Yes	No	No
CB-4062	Generator Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
CB-6062	Generator Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
Bus Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
Line Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV	Downcomer Interaction	Switchyard	Yes	No	No
Ground Disconnect	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
CCVT (3 each)	Coupling Capacitor Voltage Transformer		Downcomer Interaction	Switchyard	No	No	No
CT (6 each)	Current Transformer		Downcomer Interaction	Switchyard	No	No	No
Unit 2 Overhead Line Position 6	Dead End Structures (2 each)		Pardee Type Structure	Switchyard	Yes	No	No
CB-4072	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
CB-6072	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
Bus Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
Line Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV	Downcomer Interaction	Switchyard	Yes	No	No
Ground Disconnect	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
CCVT (3 each)	Coupling Capacitor Voltage Transformer		Downcomer Interaction	Switchyard	No	No	No
Unit 2 Overhead Line position 7	Dead End Structure		Pardee Type Structure	Switchyard	Yes	No	No
CB-4082	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
CB-6082	Feed Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
Bus Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
Line Disconnect (2 each)	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV	Downcomer Interaction	Switchyard	Yes	No	No
Ground Disconnect	3 Phase Disconnect Switch	Center Break Disconnect Switch 200 kV		Switchyard	Yes	Yes	Yes
CCVT (3 each)	Coupling Capacitor Voltage Transformer		Downcomer Interaction	Switchyard	No	No	No
Unit 2 Overhead Line Position 8	Dead End Structure		Pardee Type Structure	Switchyard	Yes	No	No
CB-4112	Cross-Tie Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
CB-6112	Cross-Tie Power Circuit Breaker	Dead Tank Gas Circuit Breaker 220 kV	IEEE 693 Qualified	Switchyard	Yes	Yes	Yes
CT (6 each)	Current Transformer			Switchyard	Yes	Yes	Yes
2L-002	Turbine Protection Cubicle			Control Building El.30	Yes	Yes	Yes
2L-014	Unitized Actuator Panel			Control Building El.30	Yes	Yes	Yes
2L-015	Turbine Supervisory Equipment Panel			Control Building El.30	Yes	Yes	Yes
2L-017	Electric Governor Cubicle			Control Building El.30	Yes	Yes	Yes
2L-048	Feedwater Control System Rack 1			Control Building El.30	Yes	Yes	Yes
2L-049	Feedwater Control System Rack 2			Control Building El.30	Yes	Yes	Yes
2L-120	Steam Bypass System Rack			Control Building El.30	Yes	Yes	Yes
2L-4	Gen. Gas Control Cubicle			Turbine Building El. 15	Yes	Yes	Yes
2/3L-104	Air Compressor Panel			Turbine Building El. 15	Yes	Yes	Yes
2L-12	Turbine Protection Cubicle			Turbine Building El. 45	Yes	Yes	Yes
2L-08	Excitation Control Cubicle			Turbine Building El. 45	Yes	Yes	Yes

Electrical Equipment

Tag	Item	Description	Comment	Location	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
2L-70	Generator Protective Relay Panel			Control Building El.15	Yes	Yes	Yes
2L-73	Turbine Auxillary Control Relay Panel			Control Building El.15	Yes	Yes	Yes
Pos. 1-17	Relay Panels			Switchyard Relay House	Yes	Yes	Yes

Explanation:
1. IEEE = Institute of Electrical and Electronics Engineers
2. kV = kilovolts
3. V = volts

Appendix D
Mechanical Equipment List

Mechanical Equipment

System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
Reactor Coolant Pumps	Pump Motor		Yes	Yes	Yes
	Oil Lift Pumps	Operating and Backup	Yes	Yes	Yes
	Other	Anti-Reverse Rotation Pumps	Yes	Yes	Yes
		ARRP Motor	Yes	Yes	Yes
		Motor and Seal Heat Exchangers	Yes	Yes	Yes
Pressurizer Relief Discharge System	Quench Tank		Yes	Yes	Yes
	Valves		Yes	Yes	Yes
Demineralized Water Makeup System	Demineralized Water Storage System	Makeup Demineralized Water Tanks	No	No	No
Ultimate Heat Sink	Main Offshore Intake Structure		Yes	Yes	Yes
	Intake Conduit	From One Pipe Section Beyond Auxiliary Intake Structure to Main Offshore Intake Structure	Yes	Yes	Yes
	Outfall Conduit	West End Box Conduit Seaward	No	No	No
Condensate Storage Facility	Condensate Storage Tank T-120		Yes	Yes	Yes
	Pumps		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Nuclear Service Water System	Storage Tank		Yes	Yes	Yes
	Pumps and Motors		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
	Other		Yes	Yes	Yes
Turbine Plant Cooling Water System	Tanks		Yes	Yes	Yes
	Pumps and Motors		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
	Heat Exchangers		Yes	Yes	Yes

Mechanical Equipment

System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
	Filters		Yes	Yes	Yes
Compressed Air System	Receivers		Yes	Yes	Yes
	Compressors		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
	Aftercoolers		Yes	Yes	Yes
	Dryers		Yes	Yes	Yes
	Filters		Yes	Yes	Yes
Chemical and Volume Control System	Tanks	Volume Control Tank	Yes	Yes	Yes
		Boric Acid Batching Tank	Yes	Yes	Yes
	Pumps	Primary Plant Makeup Pumps	Yes	Yes	Yes
	Motors	Primary Plant Makeup Pump Motors	Yes	Yes	Yes
	Piping and Valves	Letdown Portion (From Letdown Back Pressure Control Valve to Radwaste Diversion Valve)	Yes	Yes	Yes
		Volume Control Tank (Between Isolation Valves)	Yes	Yes	Yes
	Letdown Heat Exchanger		Yes	Yes	Yes
	Purification Ion-Exchanger		Yes	Yes	Yes
	Delithiating Ion-Exchanger		Yes	Yes	Yes
	Purification Filter		Yes	Yes	Yes
Normal Operation–Containment Building Ventilation Systems	Containment Normal Cooling Units	Air Handling Units	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Chillers	Yes	Yes	Yes
		Chilled Water Pumps	Yes	Yes	Yes
		Compression Tanks	Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes

Mechanical Equipment

System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
	Strainers		Yes	Yes	Yes
	CEDM Cooling System	Cooling Coils	Yes	Yes	Yes
		Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Reactor Cavity Cooling System	Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	MSIV Enclosure and Penetration Area Cooling System	Supply Fans	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
Normal Operation--Auxiliary Building Ventilation Systems	Control Room System	Air Handling Units	Yes	Yes	Yes
		Fan Coil Units	Yes	Yes	Yes
		Computer Room Fan Coil Units	Yes	Yes	Yes
		Electric Duct Heaters	Yes	Yes	Yes
		Exhaust Fans	Yes	Yes	Yes
		Transfer Fans	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Radwaste Area System	CEDMCS Room Fan Coil Units	Yes	Yes	Yes
	ESF Switchgear Room Systems	Air Handling Units	Yes	Yes	Yes
		Exhaust Fans	Yes	Yes	Yes
		Electric Duct Heaters	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Non-Class 1E Switchgear Room Systems	Exhaust Fans	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Prefilters	Yes	Yes	Yes
	Chiller Room Systems	Air Handling Unit	Yes	Yes	Yes

Mechanical Equipment

System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
		Exhaust Fan	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Battery Room Systems	Air Handling Unit	Yes	Yes	Yes
		Exhaust Fan	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Normal Chilled Water System	Chillers	Yes	Yes	Yes
		Pumps and Motors	Yes	Yes	Yes
		Air Separator	Yes	Yes	Yes
		Compression Tank	Yes	Yes	Yes
		Piping and Valves	Yes	Yes	Yes
	Continuous Exhaust System	Fans	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Plant Vent Stacks	Yes	Yes	Yes
Turbine Building Ventilation System	Switchgear Room and D6 Battery (Elevation 7') Room Systems	Supply Air Units	Yes	Yes	Yes
		Exhaust Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Electric Duct Heaters	Yes	Yes	Yes
	Lube Oil Room System	Supply Air Units	Yes	Yes	Yes
		Exhaust Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Steam Air Ejector Exhaust System	Piping and Valves	Yes	Yes	Yes
	Main Generator Iso-Phase Bus Connection Enclosure Ventilation System	Exhaust Fans and Motors	Yes	Yes	Yes
		Ductwork	Yes	Yes	Yes
	D7 Battery and Battery Charger	Supply Air Units	Yes	Yes	Yes

Mechanical Equipment

System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
	Rooms (Elevation 56')	Exhaust Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Electric Duct Heaters	Yes	Yes	Yes
Fire Protection System	Tanks		Yes	Yes	Yes
	Pumps and Motors		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Turbine-Generator	Turbine: High, Low Pressure		Yes	Yes	Yes
	Control and Protective Valve System		Yes	Yes	Yes
	Turbine Drains		Yes	Yes	Yes
	Exhaust Hood Spray System		Yes	Yes	Yes
	Lube Oil System	Components	Yes	Yes	Yes
		Piping	Yes	Yes	Yes
	Electric Turning Gear		Yes	Yes	Yes
	Turbine Control System		Yes	Yes	Yes
	Turbine Control Panel		Yes	Yes	Yes
	Turbine Supervisory System		Yes	Yes	Yes
	Turbine Protective Devices		Yes	Yes	Yes
	Turbine Overspeed Protection		Yes	Yes	Yes
	Turbine Monitoring Equipment		Yes	Yes	Yes
	Turbine Support Accessories		Yes	Yes	Yes
	Generator		Yes	Yes	Yes
	Seal Oil System		Yes	Yes	Yes
	Hydrogen Coolers		Yes	Yes	Yes
	Generator H_2/CO_2 System		Yes	Yes	Yes

Mechanical Equipment					
System	**Item/Subsystem**	**Description/Breakdown**	**Anchorage Satisfactory?**	**Free From Known Seismic Vulnerabilities?**	**Free From Seismic Interaction?**
	Stator Water System		Yes	Yes	Yes
	Exciter Switchgear and Voltage Regulator		Yes	Yes	Yes
	Exciter		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Main Steam Supply System	Reheaters		Yes	Yes	Yes
	Moisture Separator-Reheater Drain Tanks		Yes	Yes	Yes
	Main Steam Tube Bundle Drain Tanks		Yes	Yes	Yes
	Bled Steam Tube Bundle Drain Tanks		Yes	Yes	Yes
	Y-Strainers		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Main Condenser	Main Condensers		Yes	Yes	Yes
	Vent and Drain System		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Main Condenser Evacuation System	Seal Water Heat Exchanger		Yes	Yes	Yes
	Air Ejector Condenser		Yes	Yes	Yes
	Air Ejectors		Yes	Yes	Yes
	Condenser Vacuum Pump		Yes	Yes	Yes
	Seal Water Pumps		Yes	Yes	Yes
	Separator Tanks		Yes	Yes	Yes
Turbine Gland Sealing System	Gland Steam Condenser Exhaust Fan		Yes	Yes	Yes
	Gland Steam Condenser		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Turbine Bypass System	Piping and Valves		Yes	Yes	Yes
Circulating Water System	Pumps and Motors		Yes	Yes	Yes

Mechanical Equipment

System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
	Piping and Valves		Yes	Yes	Yes
	Expansion Joints		Yes	Yes	Yes
	Strainers		Yes	Yes	Yes
	Traveling Rakes and Bar Screens		Yes	Yes	Yes
	Gates #4, 5, and 6		Yes	Yes	Yes
	Gate Operators and Accessory Equipment		Yes	Yes	Yes
Condensate and Feedwater System	Tanks	Heater Drain Tanks	Yes	Yes	Yes
		Feedwater Pump Seal Drain Tanks	Yes	Yes	Yes
		Feedwater Pump Turbine Drain Tanks	Yes	Yes	Yes
	Pumps and Motors	Condensate Transfer Pumps	Yes	Yes	Yes
		Condensate Pumps	Yes	Yes	Yes
		Heater Drain Pumps	Yes	Yes	Yes
		Feedwater Pumps	Yes	Yes	Yes
		Feedwater Pump Turbine Drain Pumps	Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
	Other		Yes	Yes	Yes
	Feedwater Heaters		Yes	Yes	Yes
Steam Generator Blowdown System	Piping and Valves		Yes	Yes	Yes
	Blowdown Heat Exchanger		Yes	Yes	Yes
Turbine Plant Chemical Addition System	Pumps and Motors	Amine Feed Pumps	Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes

Explanation:

1. CEDM = Control Element Drive Mechanism
2. CEDMCS = Control Element Drive Mechanism Control system
3. MSIV = Main Steam Isolation Valve
4. H_2 = Hydrogen
5. CO_2 = Carbon Dioxide

Appendix E
Evaluation of Important-to-Reliability NSR Building Structures

E.1 INTRODUCTION

E.1.1 Objective

The objective of this assessment was to determine if any of the non-power block NSR buildings that house important-to-reliability NSR SSCs could cause a prolonged outage due to a seismic event.

E.1.2 Scope of Work

The scope of work involved 1) identifying the NSR buildings that house important-to-reliability NSR SSCs and 2) evaluating the extent of damage of the selected buildings in the event of a SONGS review level earthquake. This assessment was achieved by:

- Reviewing available structural and architectural drawings and calculations to form engineering opinions of the expected seismic performance of each building relative to other similar buildings of the same vintage located in the same seismic environment.
- Selecting an appropriate corresponding HAZUS model building type for each building based on the building's characteristics.
- Modifying the HAZUS fragility curves for the appropriate model building types using engineering judgment.
- Estimating the probable damage of each building in the event of a SONGS review revel earthquake.

The description of each selected building and the basis of the HAZUS building fragility evaluations are summarized in this appendix.

E.2 NSR BUILDINGS THAT HOUSE IMPORTANT-TO-RELIABILITY NSR SSCs

The buildings included in the scope of this study were constructed between the 1970s and 1990s. Three SONGS buildings were identified as housing important-to-reliability NSR SSCs:

- Mesa Warehouse.
- SCE Switchyard Relay House.
- SDG&E Switchyard Relay House.

The Mesa warehouse was selected because it houses replacement parts that may be required to repair important-to-reliability NSR SSCs following the occurrence of an earthquake. The SCE and SDG&E switchyard relay houses contain switchyard control instrumentation that is required for the transmission of the power generated at the plant.

E.3 ASSESSMENT PROCESS

E.3.1 Field Observations

As part of the assessment, a walk-through was completed at the Mesa warehouse and switchyard. The purpose of the walk-through was to become familiar with the buildings, observe the general conformance of the actual constructed facilities to the original drawings, and take representative photographs of the buildings' gravity and lateral load carrying systems.

E.3.2 Document Review

In addition to the walk-throughs, the structural, civil, and architectural drawings, as available, were reviewed for all three buildings. The SONGS structural design calculations were also examined. In many cases, the drawings available were not complete sets and / or information about the seismic details was lacking, which is important when making decisions about the quality factors (defined in Section E.4.6). The drawings were reviewed to develop an engineering opinion about the quality of the seismic design features and were compared with drawings of similar buildings of the same vintage and seismic zone (which were still in the Uniform Building Code (UBC) and in use at the time these buildings were designed). Summaries of the reviews are provided below.

E.3.3 Mesa Warehouse Building

E.3.3.1 Information Reviewed

The following drawings and calculations were reviewed in association with the Mesa warehouse:

- Drawing C-1: General Notes, March 30, 1982.
- Civil Drawing C-2: Offsite Warehouses Sections and Details, March 30, 1982.
- Structural Drawing S-6: 100,000 sq. ft Warehouse Foundation Sections and Details, March 30, 1982.
- Structural Drawings S-9, S-10: 100,000 sq. ft Warehouse Miscellaneous Sections and Details, September 14, 1983.

- Structural Drawing S-11: 100,000 sq. ft Warehouse Office Area Framing Plans, December 19, 1983.
- Structural Drawings S-12, S-13: 100,000 sq. ft Warehouse Office Area Framing Sections and Details, December 19, 1983.
- Structural Calculations for building frame and lateral bracing performed by Capitol Metal Buildings, Stockton, California, May 21, 1982 and June 11, 1982.
- Structural Calculations for building foundation and slab-on-grade performed by Engineering Department of S.C. Edison Co.,March 11, 1982.

E.3.3.2 Building Description

The Mesa warehouse consists of three interconnected structures. The warehouse is a single-story prefabricated metal building with dimensions of 400 ft by 250 ft. The adjacent office building has plan dimensions of 240 ft by 75 ft. The adjacent flammable material storage space has dimensions of 150 ft by 250 ft. The buildings were constructed circa 1982 using the seismic provisions of the 1979 UBC.

E.3.3.2.1 Gravity Load-Resisting System

The gravity load-resisting systems of the three buildings consist of gable type portal frames placed at 25 ft on center (o.c.). Eight inch (in.) deep gage metal Z purlins span between the frames and support the metal deck roofs that complete the gravity load-resisting system. The steel columns are supported by isolated footings. The reinforced concrete slab-on-grade is 6 in. thick.

E.3.3.2.2 Lateral Load-Resisting System

The lateral load-resisting systems of the three buildings consist of gable type portal frames in the transverse direction and X-braced frames in the longitudinal direction. The frames in the transverse direction are spaced at 25 ft o.c. and consist of tapered girders and columns with fully welded moment connections. The column base connection at the transverse moment frame columns was designed as a pinned connection. It includes four 1-1/8 in. diameter anchor rods embedded approximately 22 in. into the foundation. The X-braced frames consist of single-angle members. Lateral load from the roofs is accumulated along the purlins and transferred to the longitudinal bracing through a system of horizontal rod X bracing, whose location coincides with the location of the braced frame bays.

A gravity load-carrying column is located in the warehouse at the center of the bay that breaks up the span of the girders into two identical spans of 125 ft each. There are four bays of longitudinal bracing on each end bay.

The office building relies on the continuation of the frames from the warehouse for its lateral support in the transverse direction. Along the longitudinal direction, it has three bays of diagonal steel angle bracing.

A similar system exists in the flammable materials storage space as well. It has five bays of transverse frames and two bays of longitudinal bracing.

Using the terminology of HAZUS, the Mesa warehouse is a S3 – Steel Light Frame Structure.

E.3.3.3 Discussion

Although prefabricated metal buildings do not typically have a robust lateral system, they have performed relatively well in past earthquakes. Based on the review of the moment connections, it is expected that they will have a performance similar to pre-Northridge earthquake connections of similar vintage. However, due to the relatively large spans of the girders, it is likely that the building has inadequate lateral stiffness to prevent damage due to seismic loads in the transverse direction. In the longitudinal direction, the resistance is provided by ordinary single angle tension braces only, since the compression braces are expected to buckle and provide negligible lateral resistance. In addition to these deficiencies, past experience with these types of buildings has indicated that the rod bracing at the roof diaphragm level will likely not be adequate to prevent damage, thereby providing an indirect load path for the seismic loads.

E.3.3.4 Recommendations

It is recommended that a quality factor (see Section E.4.6) of 1.2 be used both for transverse loading and longitudinal loading relative to buildings similar to the vintage of the Mesa warehouse.

E.3.4 Switchyard Relay Houses

E.3.4.1 Information Reviewed

The following calculation was used to perform this review:

- Structural Calculations for San Onofre Generating Station, 220 kilovolt (kV) Switchyard, October 14, 1975 performed by Bechtel.

E.3.4.2 Building Description

The two switchyard relay houses are referred to as the SCE building and the SDG&E building. Both are roughly of equal size, rectangular in plan with major dimensions of 35 ft by 28 ft. The roof of each is about 11 ft above the finished floor. One edge of each of the buildings is buried into the sloping ground with the concrete wall acting as a retaining wall. The remaining walls of the buildings are of reinforced masonry. The buildings were constructed circa 1974 using the provisions of the 1973 UBC. However, the design calculations point out that an internal SCE criterion requiring the structures to be designed for a base shear capacity of 0.5g was used. Due to similar construction, a single assessment was applied to the two switchyard relay houses.

E.3.4.2.1 Gravity Load-Resisting System

Structural and architectural drawings of the buildings were unavailable. Design calculations show that the perimeter walls along with an open-steel, open-web joist system and the 1-1/2 in. deep metal deck with 3 in. concrete topping constitute the gravity load-resisting system.

E.3.4.2.2 Lateral Load-Resisting System

The lateral load-resisting systems of the switchyard relay houses include the perimeter reinforced masonry walls along with the concrete shear wall that also acts as the retaining wall. The masonry walls are grouted at 32 in. o.c. with a #5 bar in the cell. Remaining cells are also grouted with Zonolite masonry fill up to the bond beam level. The roof diaphragm of each structure is a 1-1/2 in. deep metal deck with 3 in. deep concrete topping.

E.3.4.3 Discussion

The switchyard relay houses have been designed to a high level of base shear, even compared to the current 2007 California Building Code (CBC). The steel deck roof diaphragm is positively attached (through welding) to the masonry walls with steel angles that are connected to the masonry walls with 7/8 in. diameter cast in place bolts placed at 16 in. o.c. These structures are expected to behave in a superior fashion in an earthquake.

Using the terminology of HAZUS, the switchyard relay houses can be classified as a C2L – Low Rise Concrete Shear Wall Building. The other possible classification as a RM2L – Reinforced Masonry Bearing Wall with Precast Concrete Diaphragms is not applicable.

E.3.4.4 Recommendations

As a result of reviewing the calculations, it is recommended that a quality factor (see Section E.4.6) of 0.8 be used for the HAZUS analysis of the switchyard relay houses.

E.4 BUILDING FRAGILITY

E.4.1 HAZUS Fragility Data

HAZUS is national consensus software developed by the FEMA to help estimate damage to the built environment as the result of future scenario earthquakes (FEMA, 2003, 2005). One of its primary purposes of the software is to help government agencies evaluate risks, and the software includes national databases embedded within. This software is described in the Technical Manual. There is also an Advanced Engineering Building Module (AEBM) Manual, which is an extension of the general methods in HAZUS intended for use in estimating individual building losses.

In developing HAZUS, fragility curves for different model building types (e.g., steel light frame buildings) were determined. An example of a fragility curve is shown on Figure E.4-1. Generally the cumulative probability of reaching a damage state for a given level of deformation (drift) or severity of shaking (e.g., PGA) is plotted. This plot is usually generated assuming a lognormal distribution of damage, with a corresponding median and beta (logarithmic standard deviation).

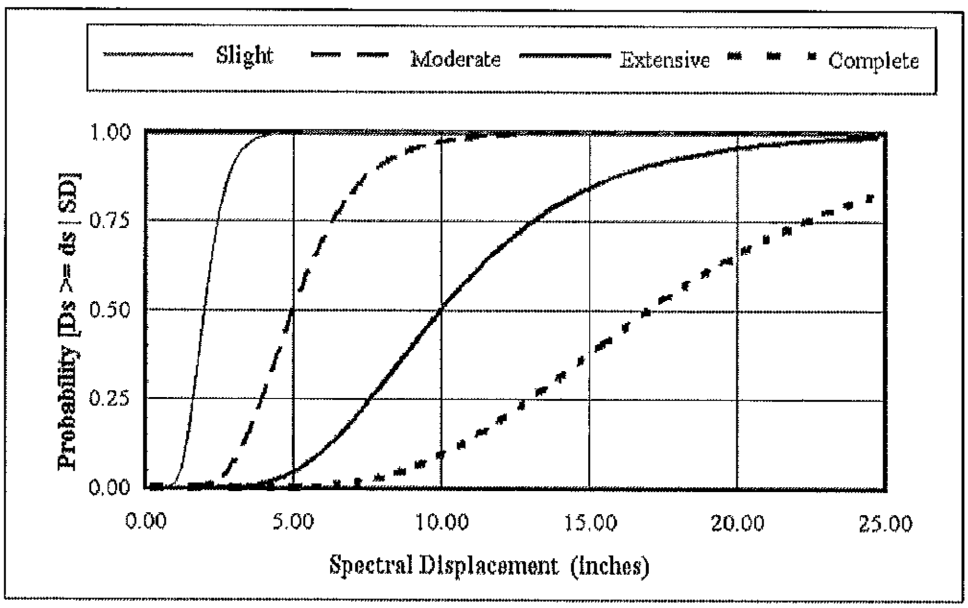

Figure E.4-1 Sample Fragility Curves

E.4.2 Displacement vs. PGA

While most of the fragility data in the HAZUS Technical Manual is based on building displacements, an alternate procedure that is based on PGA data is also presented. This alternate procedure was used is this evaluation.

E.4.3 Damage States

In the case where different damage states are defined for a building, fragility curves can be developed for each damage state. In HAZUS, the damage states defined are slight, moderate, extensive, and complete. HAZUS fragility functions are provided for each damage state.

The HAZUS Technical Manual indicates that the moderate damage state has 5 to 25% damage, and that it corresponds with a green tag after an earthquake. Moderate damage may be localized. A green tag means that the building has been inspected and that no significant weakening of the structure has occurred. Thus, there are no restrictions on occupancy.

Furthermore, the HAZUS Technical Manual indicates that the extensive damage state has 25 to 100% damage, and corresponds with a yellow tag after an earthquake. A yellow tag means occupancy is restricted but that sufficient reserve capacity exists and that collapse is not expected if an aftershock were to occur. The building cannot be occupied as it was before the earthquake occurred unless some action is taken. Some portion of the building may be unsafe. Generally occupants are permitted to remove important belongings through brief visits until the damage is mitigated, or until the likelihood of a significant aftershock decreases.

Finally, the HAZUS Technical Manual indicates that the complete damage state corresponds with 100% damage, which corresponds with a red tag. A red tag indicates that the building is unsafe and that there is a risk of collapse on its own or due to an aftershock. No entry into the building is permitted, even to conduct repairs or remove important belongings. However, the complete damage state does not necessarily correspond with the physical collapse of a building. In general, the complete damage state implies that building repair costs exceed the cost of building replacement. The HAZUS collapse rates for the various building types are not uniform and range from 3% (wood frame buildings) to 15% (un-reinforced buildings).

As indicated above, fragility curves for different model building types are included in the HAZUS documentation. Model building types of relevance for this study are concrete shear wall buildings (C2) and steel light frame buildings (S3). HAZUS also differentiates between low-rise, mid-rise, and high-rise buildings. All the buildings included in this study qualify as low-rise buildings.

For each model building type, HAZUS also provides fragility data corresponding to different seismic design levels. The fragility data was developed in the 1990s when seismic zones defined in the UBC were still in use. High-Code is intended to reflect design practice in Seismic Zone 4 after 1975; Moderate-Code is representative of the design practice in Seismic Zone 2B after 1975; and Low-Code is intended to reflect design practice in Seismic Zone 1 after 1975. The AEBM Manual indicates that for buildings constructed between 1941 and 1975 the appropriate design levels should be reduced by one. Only the switchyard relay houses fall into this category. However, the switchyard relay houses were designed for an elevated base shear capacity appropriate for High-Code classification. Buildings constructed prior to 1941 are considered pre-Code and have a different set of fragility data. Thus, there are fragility data for four seismic design levels included in HAZUS.

E.4.4 Design Level

At the time these three buildings were constructed (1970 to 1990), the region that SONGS is located in was considered Seismic Zone 4, according to the UBC. The switchyard relay houses, on the other hand, although designed per 1973 UBC, used the internal SCE guideline of 0.5g base shear coefficient for seismic design qualifying it for the High-Code seismic design level. Based on this information, it was determined that the fragility data associated with the High-Code seismic design level is appropriate for all the buildings.

E.4.5 Fragility Data for Generic Building Types

The median PGA provided in the HAZUS Technical Manual for the fragility curves is given in Table E.4-2. As noted above, these values correspond to High-Code Design.

Table E.4-2 Fragility Data for Generic Building Types

Building Type	Damage State			
	Slight	Moderate	Extensive	Complete
	PGA Median, g	PGA Median, g	PGA Median, g	PGA Median, g
C2L	0.24	0.45	0.90	1.55
S3	0.15	0.26	0.54	1.00

E.4.6 Quality Factor

HAZUS fragility data are intended to represent the average building type of a certain height and age, and are designed using specific building code provisions. However, not all buildings designed under such conditions will perform equally in an earthquake. Based on the drawing review, an assessment was made on whether a building was better or worse than the average building. A quality factor that is used to scale the median of the fragility data was used. In this study, quality factors ranged from 0.8 to 1.2, with 1.2 representing a building with a median that is 1/1.2 lower than the average. Quality factors assigned for each building were presented in Section E.3.

The quality factor not only is used to reflect the superior or inferior detailing or configurations, it also incorporates what was learned by reviewing the drawings or design criteria about the importance factors used in the design. Thus, the quality factor for the switchyard relay houses was decreased to account for the high design base shear coefficient.

E.4.7 Expected Building Fragility Levels

E.4.7.1 Moderate Damage

The fragility level for each of the three structures being in the moderate damage state is listed in Table E.4-3. The generic fragility values of Table E.4-2 are modified by dividing them by the quality factor.

Table E.4-3 Fragility Corresponding with Moderate Damage State

Building	HAZUS Building Type	Quality Factor	Median Fragility, g
Mesa Warehouse	S3	1.2	0.22
Switchyard Relay Houses (2)	C2L	0.8	0.56

Note: Fragilities for all buildings assume High-Code Design.

E.4.7.2 Extensive Damage

The fragility level for each of the three structures in the extensive damage state is listed in Table E.4-4. The generic fragility values of Table E.4-2 are modified by dividing them by the quality factor.

Table E.4-4 Fragility Corresponding with Extensive Damage State

Building	HAZUS Building Type	Quality Factor	Median Fragility, g
Mesa Warehouse	S3	1.2	0.45
Switchyard Relay Houses (2)	C2L	0.8	1.13

Note: Fragilities for all buildings assume High-Code Design.

E.4.7.3 Complete Damage

The fragility level for each of the three structures in the complete damage state is listed in Table E.4-5. The generic fragility values of Table E.4-2 are modified by dividing them by the quality factor.

Table E.4-5 Fragility Corresponding with Complete Damage State

Building	HAZUS Building Type	Quality Factor	Median Fragility, g
Mesa Warehouse	S3	1.2	0.83
Switchyard Relay Houses (2)	C2L	0.8	1.94

Note: Fragilities for all buildings assume High Code Design.

E.5 CONCLUSIONS

For the SONGS review revel earthquake, the two switchyard relay houses will sustain only moderate damage and will be green tagged after the earthquake and thus will remain functional. However, the Mesa warehouse will sustain extensive damage and will be yellow tagged following a SONGS review level earthquake and access to the building will be restricted.

The HAZUS damage states used in this evaluation correspond with the structural damage states. Nonstructural components within the building were not directly evaluated; however, they were observed during the walk-through of each building. The relay panels and equipment within the switchyard relay houses are all anchored and braced to the ceiling joists. These components were screened for the SONGS review level earthquake during the equipment walkdowns.

E.6 REFERENCES

FEMA, 2003, Department of Homeland Security and Response Directorate, Federal Emergency Management Agency, Mitigation, Division, Multi-hazard Loss Estimation Methodology, Earthquake Model, HAZUS-MH MR1, Advanced Engineering Building Module, Washington, D.C..

FEMA, 2005, Department of Homeland Security and Response Directorate, Federal Emergency Management Agency, Mitigation, Division, Multi-hazard Loss Estimation Methodology, Earthquake Model, HAZUS-MH MR4, Technical Manual, Washington, D.C..